I-19 CORRIDOR PROFILE STUDY

NOGALES TO JUNCTION I-10

ADOT Work Task No. MPD 072A-14
ADOT Contract No. ADOT 11-013177

Draft Working Paper 4: Corridor Needs Assessment

June 2015

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ACRONYMS

ADOT	Arizona Department of Transportation
AZTDM	Arizona Travel Demand Model
DCR	Design Concept Report
FY	Fiscal Year
HCRS	Highway Condition Reporting System
HERE	Real time traffic conditions database produced by American Digital Cartography Inc.
HPMS	Highway Performance Monitoring System
I-19	Interstate 19
LOS	Level of Service
MP	Milepost
NB	Northbound
OP	Overpass
PAG	Pima Association of Governments
P2P	Planning to Programming
PDI	Pavement Distress Index
PSR	Pavement Serviceability Rating
PTI	Planning Time Index
SB	Southbound
SHSP	Strategic Highway Safety Plan
SPUI	Single Point Urban Interchange
SR	State Route
TI	Traffic Interchange
TIP	Transportation Improvement Plan
TPTI	Truck Planning Time Index
TTI	Travel Time Index
TTTI	Truck Travel Time Index
UP	Underpass
V/C	Volume to Capacity Ration

1   INTRODUCTION

Interstate 19 (I-19) is a major corridor for intrastate and international commerce between Mexico and the United States. It is one of nine Arizona Department of Transportation (ADOT) defined corridors that play a key role in the understanding the overall health of the statewide transportation system. The statewide plan, *What Moves You Arizona*, and the *Planning to Programming Linkage (P2P)* have begun developing a framework to integrate the planning and programming process in a transparent, defensible, logical, and reproducible way. The I-19 Corridor Profile Study is one piece that will begin to connect strategic decisions to on-the-ground improvements.

1.1   Corridor Study Purpose

This series of corridor profile studies will examine significant state corridors and compare performance to goals using performance measures identified in the P2P process. The purpose of these studies will be to identify the gap between measured performance and stated goals and to perform a comparative analysis both within the I-19 corridor and with other statewide significant corridors. This effort will result in the prioritization of solutions that will improve the overall performance of the I-19 corridor. The process by which this corridor profile study will achieve the desired results will focus on the following process areas:

- Inventory past recommendations for improvements that have been completed or are in progress;
- Provide an overall assessment of the existing health of the corridor, based on system performance measures;
- Recommend a range of solution sets to help improve the overall performance;
- Determine how proposed corridor improvements will be prioritized based on a risk-based decision process; and
- Complete a P2P ranking of proposed improvements and recommend strategic initiatives.

1.2   Corridor Study Objectives

The I-19 Corridor Profile Study will define solution sets and improvements that can be evaluated and ranked to determine which investments offer the greatest benefit to the corridor. Corridor benefits will be documented by three investment types including preservation, modernization, and expansion. The main objective of this study will be to identify potential actions that will increase the performance of the I-19 corridor to acceptable levels. These actions or projects will be analyzed based on risk potential, life-cycle costs, and cost-benefits to produce a prioritized list of projects that help achieve corridor goals. The following goals have been identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals;
- Match solutions with deficiencies in measured performance; and
- Prioritize improvements that efficiently preserve, modernize, and expand transportation infrastructure.

1.3   Study Location and Corridor Segments

The I-19 Corridor is a multi-modal corridor located in southern Arizona that serves international, regional, and local traffic and commerce demand between the United States and Mexico. I-19 spans approximately 64 miles from the international border near Nogales, Arizona north to the junction with Interstate 10 (I-10) at milepost 63.69 in Tucson, Arizona as illustrated in **Figure 1.**

The I-19 Corridor is divided into six planning segments for analysis and evaluation. These planning segments allow the corridor to be analyzed at a detailed level so that location-specific needs can be readily identified and compared to other segments on this or other corridors. Segmentation by similar characteristics will allow the analysis to highlight anomalies or instances of poor performance within the context of each segment. Planning segments for the I-19 Corridor are defined in **Table 1.**

The planning segments were created to define a consistent method of grouping data and to define a level of granularity appropriate for supporting long range corridor-level priority decisions. In order to measure and compare planning segments to each other and to the system as a whole, the root data set is normalized to represent each planning segment. The data is utilized either as point source information, e.g., specific location of an accident, or by length, e.g., a series of maintenance sections with a specific pavement condition.

Table 1: I-19 Corridor Segments

Seg	Segment Name	Begin Milepost	End Milepost	Surface Width (NB)	Thru Lanes (NB)	Length (mi)
1	US Border to SR 189 TI	0.00	2.95	24'-36'	2	2.95
2	SR 189 TI to Santa Gertudis TI (Rock Corral Rd)	2.95	18.24	24'-36'	2	15.29
3	Santa Gertudis TI to Arivaca Rd TI	18.24	30.09	24'	2	11.85
4	Arivaca Rd TI to Continental Rd TI	30.09	39.55	24'	2	9.46
5	Continental Rd TI to San Xavier Rd TI	39.55	57.18	24'-36'	2	17.63
6	San Xavier Rd TI to I-10	57.18	63.69	24'-48'	2-3	6.51

1.4   Working Paper 4 Overview

This Working Paper focuses on the performance-based needs identified for the I-19 corridor. Corridor Needs are defined as the gap between the baseline system performance (Task 2) and the performance objectives from Task 3. This multi-step process is based on the Performance System and will be supplemented by additional data required to more specifically identify needs at the corridor and segment level. This result of this analysis will define actionable performance needs that can be addressed through strategic investments.

Figure 1: I-19 Corridor Study Area and Segment Characteristics

I-19 Corridor Segments:

Segment 19-1: US Border to SR 189 TI (MP 0 - 2.95)

Segment 19-2: SR 189 TI to Sanga Gertudis TI (MP 2.95 - 18.22)

Segment 19-3: Santa Gertudis TI to Aravaca Rd TI (MP 18.22 - 30.07)

Segment 19-4: Aravaca Rd TI to Continental Rd TI (MP 30.07 - 39.53)

Segment 19-5: Continental Rd TI to San Xavier Rd TI (MP 39.53 - 57.19)

Segment 19-6: San Xavier Rd TI to I-10 (MP 57.19 - 63.70)

I-19 Corridor Profile Study: Nogales to Junction I-10
Corridor Study Area and Segment Characteristics

MILES
0   5   10

LAND OWNERSHIP

Corridor Segment

US Hwy/State Route

County Boundary

City Boundary

Traffic Interchange/Grade Separation

Bureau of Land Management

Bureau of Reclamation

U.S. Forest Service

National Park Service

U.S. Fish and Wildlife Service

Indian Reservation

Military

Local or State Parks

State Trust Land

State Game and Fish

Private

City Limits

2   CORRIDOR NEEDS ASSESSMENT PROCESS

A collaborative process involving ADOT Multimodal Planning Department (MPD) staff and the corridor profile study teams for I-17, I-19, and I-40 was used to develop a framework for the performance-based needs assessment process. The following guiding principles were developed as an initial step in process development:

- Corridor needs should be defined as deficiencies in performance.
- The needs assessment process should be systematic, progressive, and repeatable.
- The process should consider all primary and secondary performance measures developed in Task 2 of the study.
- The process should develop multiple need levels including programmatic needs for the entire length of the corridor, performance area-specific needs, segment-specific needs, and location-specific needs (defined by milepost limits).
- The process should be automated and include engineering judgment.
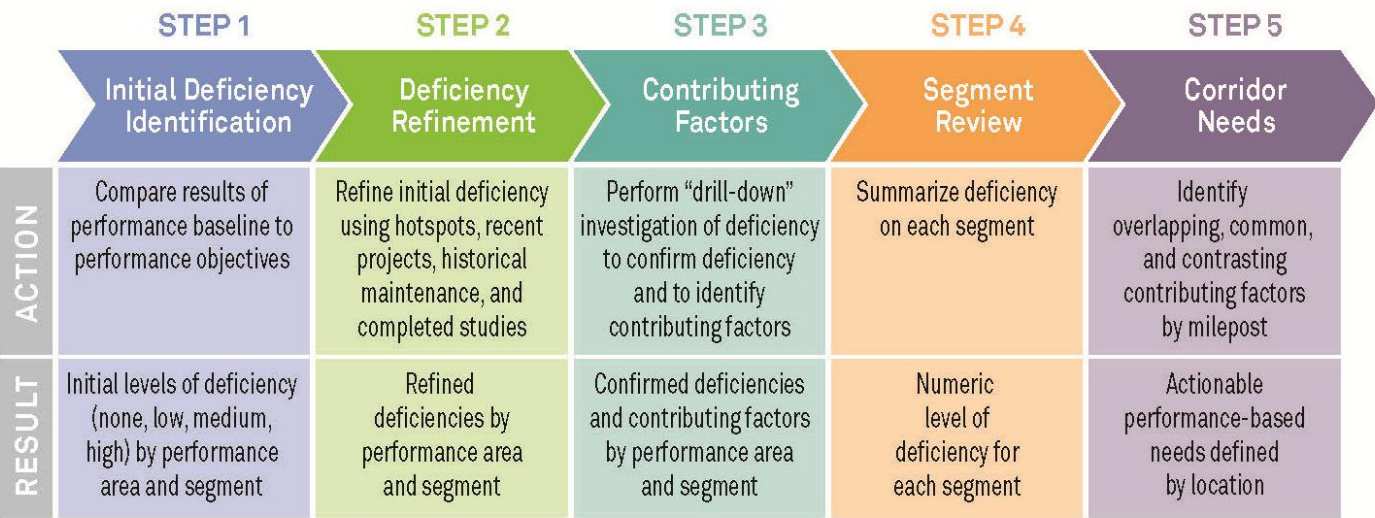- The process should produce actionable needs and deficiencies that can be addressed through strategic investments in corridor preservation, modernization, and expansion.

The performance-based needs assessment process is illustrated in **Figure 2** and described in the following sections of the working paper.

Figure 2: Needs Assessment Process

2.1   Step 1: Initial Deficiencies

The first step in the needs assessment process links baseline (existing) corridor performance documented in Draft Working Paper 2 with performance objectives documented in Draft Working Paper 3. In this step, the baseline corridor performance is compared to the performance objectives to provide a starting point for the identification of performance deficiencies. This mathematical comparison results in an initial deficiency rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown in Figure 3.

Figure 3: Initial Deficiency Ratings in Relation to Baseline Performance

Performance Thresholds	Performance Level	Initial Level of Deficiency	Description
3.75	Good	None	All levels of Good and top 1/3 of Fair (>3.57)
	Good		
	Good		
	Fair		
	Fair	Low	Middle 1/3 of Fair (3.38-3.57)
3.20	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (3.02-3.38)
	Poor		
	Poor	High	Lower 2/3 of Poor (<3.02)
	Poor		

Initial levels of deficiency for each performance measure are combined to produce a weighted initial deficiency rating for each segment. Values of 0, 1, 2, and 3 are assigned to the initial deficiency levels of None, Low, Medium, and High, respectively. A weight of 1.0 is applied to the Performance Index deficiency and equal weights of 0.20 are applied to each deficiency for each secondary performance measure. For directional secondary performance measures, each direction of travel receives a weight of 0.10. The secondary performance measure deficiencies are added to the deficiency from the Primary Index to create a cumulative measure of deficiency. The resulting weighted initial level of deficiency is assigned a level of None, Low, Medium, or High. With this approach, the resulting segment level of deficiency will always be equal to or higher than the Primary Index deficiency.

2.2   Step 2: Deficiency Assessment

In Step 2, the initial level of deficiency for each segment is refined using the following information and engineering judgment:

- If an initial performance deficiency was not identified, the existence (or frequency) of hot spots in the segment may provide justification to increase the initial level of deficiency from 'None' to 'Low'.
- Maintenance history or the level of past investments may provide justification to increase the initial level of deficiency.
- Field observations from ADOT district personnel may provide justification to increase the initial level of deficiency for maintenance issues that may not be evident from other performance metrics.
- Recently completed projects or projects under construction may provide justification to lower or eliminate a deficiency.
- Previous studies may provide additional information regarding a deficiency.
- Programmed projects may provide justification to lower the initial level of deficiency; however further investigations may suggest that changes in the scope of a programmed project are warranted.

The resulting refined deficiency (an increase or decrease from initial deficiency) will be carried forward for further evaluation in Step 3.

2.3 Step 3: Contributing Factors

In Step 3, a more detailed review of the condition and performance data available from ADOT was conducted to confirm the refined deficiencies and identify contributing factors for the deficiency. Typically, the same databases that were used to develop the baseline performance served as the principle sources for detailed diagnostic analysis. However, other supplemental databases were also useful sources of information. The databases used for diagnostic analysis are listed below.

Pavement Performance Area

- Pavement Rating Database

Bridge Performance Area

- Bridge Information and Storage System
- Bridge Inspection Reports

Mobility Performance Area

- Highway Performance Monitoring System (HPMS) Database
- AZ Travel Demand Model (AZTDM)
- HERE Database
- Highway Conditions Reporting System (HCRS) Database

Safety Performance Area

- Crash Database

Freight Performance Area

- HERE Database
- HCRS Database

Step 3 resulted in the identification of performance-based deficiencies and contributing factors by segment (and milepost locations, if appropriate) that can be addressed through investments in preservation, modernization, and expansion projects to improve corridor performance.

2.4 Step 4: Segment Review

In this step, the deficiencies from Step 3 were quantified for each segment to numerically estimate the level of deficiency for each segment. Values of 0, 1, 2, and 3 are assigned to the final deficiency levels (from Step 3) of None, Low, Medium, and High, respectively. A weight of 1.5 is applied to the performance areas that were identified as Emphasis Areas for each corridor in Draft Working Paper 3 and a weighted average deficiency is calculated for each segment. The resulting deficiency value can be used to compare across corridors and to determine the location of the highest deficiencies on a given corridor at a segment level.

2.5 Step 5: Corridor Needs

In this step, performance-based deficiencies and contributing factors transition to corridor needs. Needs are defined as "actionable" to facilitate development of solution sets for preserving, modernizing, and expanding corridor investments. The deficiencies and contributing factors for each performance area are reviewed on a segment-by-segment basis to identify needs. This review compares and contrasts performance-based deficiencies to identify actionable needs and to facilitate the formation of solution sets that address multiple performance areas and contributing factors. The intent of this process is to identify overlapping, common, and contrasting needs to help develop strategic solutions. This step results in the identification of corridor needs by specific location.

3 PAVEMENT PERFORMANCE AREA NEEDS

The following sections describe the needs assessment process for the I-19 corridor for the Pavement Performance Area. The process examines initial deficiencies as determined through data analysis, and then adjusts for other factors not included in the baseline analysis.

3.1 Step 1: Initial Pavement Deficiencies

Step 1 uses the Pavement Index and two secondary performance measures (Directional PSR and Percent Pavement Failure) that were documented in Working Paper #2 to establish the baseline performance data. The baseline performance data and performance objectives (Working Paper #3) for the I-19 corridor were used to determine the Initial Deficiencies as described in Section 2.1. The pavement condition data used to calculate baseline performance was provided by ADOT for the timeframe from 2012 to 2013. The results of Step 1 are shown in **Table 2.**

The I-19 corridor shows very good overall pavement ratings with initial deficiencies for each segment rated as 'None' or 'Low.' **Appendix A** defines the detailed calculations used to determine the initial pavement deficiency levels.

3.2 Step 2: Pavement Deficiency Refinement

The Initial Deficiencies for the I-19 corridor were refined as described in Section 2.2. The locations of pavement failure hot spots, level of previous investment, and recent projects that would supersede the condition data were used to refine the deficiencies. A summary of this process is shown in **Table 3**.

Pavement Hot Spots

The locations of pavement failure (hot spots) are listed in **Table 3**. If an Initial Deficiency was not identified in Step 1, the existence of hot spots would be justification for increasing the deficiency from 'None' to 'Low' in Step 2. In Segment 19-2, the level of deficiency has been increased due to a hotspot located at MP 17-18 in the northbound direction where frequent pavement failures have resulted in shorter than optimal rehabilitation schedules.

Historical Investment Data

ADOT provided pavement rehabilitation project data for the last 20 years which was used to estimate the level of previous investment in each segment and is summarized in **Figure 4**. Additional information regarding the determination of the level of previous investment is contained in the Appendix. If a segment has a high level of previous investment, the level of deficiency was increased in Step 2.

Previous Projects

Previous projects that would supersede the pavement conditions data are also listed in **Table 3**. In Step 2, this information was used to lower or eliminate deficiencies on segments where recent paving projects have been completed. The level of deficiency was adjusted from 'Low' to 'None' in Segment 19-1 where an ongoing pavement preservation project is addressing the deficiency level.

Table 2: Initial Pavement Deficiencies (Step 1)

Segment	Segment Mileposts	Segment Length (miles)	Pavement Index			Directional PSR						% Pavement Failure			Initial Deficiency
			Performance Score	Performance Objective	Level of Deficiency	Performance Score		Performance Objective	Level of Deficiency		Performance Score	Performance Objective	Level of Deficiency	
						NB	SB		NB	SB				
19-1	0-3	3	4.03	Fair or Better	None	3.72	3.96	Fair or Better	None	None	16.67%	Fair or Better	Medium	Low
19-2	3-18	15	4.39	Fair or Better	None	4.28	4.26	Fair or Better	None	None	3.33%	Fair or Better	None	None
19-3	18-30	12	3.57	Fair or Better	None	3.74	3.90	Fair or Better	None	None	0.00%	Fair or Better	None	None
19-4	30-40	9	3.54	Fair or Better	Low	3.76	3.90	Fair or Better	None	None	0.00%	Fair or Better	None	Low
19-5	40-57	18	4.08	Fair or Better	None	3.97	4.02	Fair or Better	None	None	0.00%	Fair or Better	None	None
19-6	57-64	7	3.61	Fair or Better	None	3.54	3.57	Fair or Better	Low	None	18.75%	Fair or Better	Medium	Low
Weighted Average			3.93	Fair or Better	None									

Figure 4: Pavement History

Mile Post Markers: 0 1 4 12 20 28 32 40

Corridor Segment

Segment 1 | Segment 2 | Segment 3 | Segment 4 | Segment 5

Pavement Preservation Projects (Segments 1-5) 1994-2014

1999 (NB/SB) H497801C — Remove 0.5", New 0.5" AR/ACFC — 5 — 7 — 9

6

2008 (NB/SB) H480301C — Remove 3", New 4.5" AC, New 0.5" AR/ACFC — 1 — 4 — 10

2012 (NB/SB) H836301C: Crack Seal (Rubberized)

1a — 2 — 2 — 3 — 3

1999 SB H523001C: 0.6" Seal Coat

8 — 1998 NB H355801C: Remove 4", New 4" AC, New 0.5" AR/ACFC

1998 (NB/SB) H355701C: Remove 6", New 5.5"AC, New 0.5" AR/ACFC

Mile Post Markers: 48 52 60 64

Corridor Segment

Segment 5 | Segment 6

Pavement Preservation Projects (Segments 5-6) 1994-2014

9 — 1994 (NB/SB) H310201C: Remove 5", New 5" AC, New 0.5" AR/ACFC — 13 — 14 — 15 — 16

10 — 11 — 12

Legend

- ■ New Paving or Reconstruction
- ■ Mill and Overlay (Adding Structural Thickness)
- ■ Mill and Replace (No Change Structural Thickness)
- □ Fog Coat or Thin Overlay Treatments
- ⬚ PCCP Pavement Border
- □ AC Pavement Border

Pavement Treatment Reference Numbers

1. 2007 (NB/SB) H636701C: .26 -.27 Remove 3.5", New 3" AC New 2" AR - AC, New 0.5" AR/ACFC
1a. 2007 (NB/SB) H636701C: .27 -.35 Remove 2", New 2" AR-AC New 0.5" AR/ACFC
2. 2003 (SB) H625401C: 6-6.3 Remove 2", New 2" AC,
3. 1996 (NB) H322801C: Remove 4", 6.5" AC, New 0.5" AR?ACFC
4. 1996 (NB/SB) H322801C: Remove 3.25", New 5.75" AC, New 0.5" AR/ACFC
5. 1998 (NB/SB) H379801C: Remove 4", New 4" AC, New 0.5" AR/ACFC
6. 1998 (NB) H355801C: Remove 4", New 4" AC, New " AC/ARACFC
7. 1998 (SB) H355801C: Remove 4" New 4" AC, New 4" AR/ACFC
8. 1998 (NB) H355801C: Remove 6.5", New 4" AC, New 0.5" AR/ACFC
9. 1994 (NB/SB) H310201C: New 2" AC, New 0.5" AR/ACFC:
10. 1994 (NB/SB) H310201C: Remove 3.5", New 5.5" AC, New 0.5" AR/ACFC
11. 2001 (NB/SB) H480401C: Remove 4.5", New 4" AC, New 2" AR-AC, New 0.5" AR/ACFC
12. 2001 (NB/SB) H480401C: New 1" AR/ACFC
13. 2002 (NB/SB) H260901C: Remove 0.5", New 0.5" AR/ACFC
14. 2006 (NB/SB) H659501C: New 1" Recycled AC Overlay
15. 2005 (NB/SB) H319003C: New 4" AC New 15.25" PCCP
16. 2005 (NB/SB) H661301C: New 4" AC New 15.25" PCCP

Table 3: Refined Pavement Deficiencies (Step 2)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Initial Deficiency	Deficiency Adjustments			Refined Deficiency	Comments (may include programmed projects or issues from previous reports)
				Hot Spots	Historical Investment	Previous Projects (supersede condition data)		
19-1	0-3	3	Low	NB MP 0.00-1.00	Medium	None	Low	Failure hot spot NB (MP 0-1); Medium level of historical investment; Pavement Preservation project from MP 0 – MP 3 is programmed in FY 15
19-2	3-18	15	None	NB MP 17.00-18.24	High	None	Low	Failure hot spot NB (MP 17-18) and 'High' level of historical investment result in an increased level of deficiency; Pavement Preservation (RR[4" TL, 3" PL] + FR) from MP 16 - MP 21 is programmed in FY 15
19-3	18-30	12	None	None	Low	None	None	Pavement Preservation project from MP 21 – MP 32 is programmed in FY 19
19-4	30-40	9	Low	None	Medium	None	Low	Medium level of previous investment; Pavement Preservation MP 32 - MP 43 is programmed in FY 19
19-5	40-57	18	None	None	Medium	None	None	
19-6	57-64	7	Low	NB & SB MP 62.00-63.00 SB MP 63.00-63.69	Medium	None	Low	Failure hot spot NB and SB (MP 62-63); Medium level of historical investment; Mainline reconstruction project from MP 58 – MP 62 is programmed in FY 15 and FY 18

3.3   Step 3: Pavement Contributing Factors

The Refined Deficiencies for the I-19 corridor were further investigated as described in Section 2.3. For the Pavement Performance Area, no additional information is readily available to help determine what has contributed to pavement hotspots. The contributing factors identify the specific locations of deficiencies, areas of high historical investment, and provide additional supporting information available from the ADOT Districts. A summary of this process is shown in **Table 4**.

Final Deficiencies

After reviewing all of the information provided in Step 3, a Final Deficiency level was determined for each segment. This deficiency level would only deviate from the Refined Deficiency if the analysis of Step 3 identified a previously unknown performance issue (which would increase the deficiency level), or identified that there are no observable issues (which would decrease the deficiency level). No adjustments were made to the Final Deficiency levels along the I-19 corridor.

Table 4: Pavement Contributing Factors (Step 3)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Refined Deficiency	Contributing Factors and Comments	Final Deficiency
19-1	0-3	3	Low	Failure hot spot NB (MP 0-1); Medium level of historical investment; Project is programmed in FY 15 should mitigate issues	Low
19-2	3-18	15	Low	Failure hot spot NB (MP 17-18); High level of historical investment (MP 6-9); Project is programmed in FY 15 should mitigate issues	Low
19-3	18-30	12	None		None
19-4	30-40	9	Low	Medium level of previous investment; Project is programmed in FY 19 should mitigate issues	Low
19-5	40-57	18	None		None
19-6	57-64	7	Low	Failure hot spot NB and SB (MP 62-63); Medium level of historical investment; Project programmed in FY 15 and FY 18, project limits will not address full extent of identified deficiency as currently programmed.	Low

4 BRIDGE PERFORMANCE AREA NEEDS

The following sections describe the needs assessment process for the I-19 corridor for the Bridge Performance Area. The process examines initial deficiencies as determined through data analysis, and then adjusts for other factors not included in the baseline analysis.

4.1 Step 1: Initial Bridge Deficiencies

Step 1 uses the Bridge Index and three secondary performance measures (Bridge Rating, Bridge Sufficiency, and Percent Functionally Obsolete Bridges) that were documented in Working Paper #2 to establish the baseline performance data. The baseline performance data and performance objectives (Working Paper #3) for the I-19 corridor were used to determine the Initial Deficiencies as described in Section 2.1. The bridge condition data used to calculate baseline performance was provided by ADOT for the timeframe from 2012 to 2014. The results of Step 1 are shown in **Table 5.**

Notably, all four bridges in Segment 19-1 are listed as functionally obsolete. Bridge ratings are also notably low in segment 19-5, resulting in a high level of deficiency. **Appendix A** defines the detailed calculations used to determine the initial bridge deficiency levels.

4.2 Step 2: Refined Bridge Deficiency

The Initial Deficiencies for the I-19 corridor were refined as described in Section 2.2. The locations of bridge failure hot spots, historical trends, number of functionally obsolete bridges, and recent projects that would supersede the condition data were used to refine the deficiencies. A summary of this process is shown in **Table 6**.

Bridge Hot Spots

The locations of structurally deficient bridges (hot spots) are listed in **Table 6**. If a segment has a structurally deficient bridge (hot spot) the level of deficiency was increased in Step 2.

Historical Investment Data

ADOT provided historical bridge rating data for the last 17 years which was used to investigate historical trends for each bridge and is summarized in **Figure 5**. If a bridge had repetitive previous investments related to the same issue, the level of deficiency was increased in Step 2. In Segment 19-2, a high percentage of bridges were identified for more in-depth review due to historically low scores and needs identified in local plans, resulting in refining the level of deficiency from low to medium.
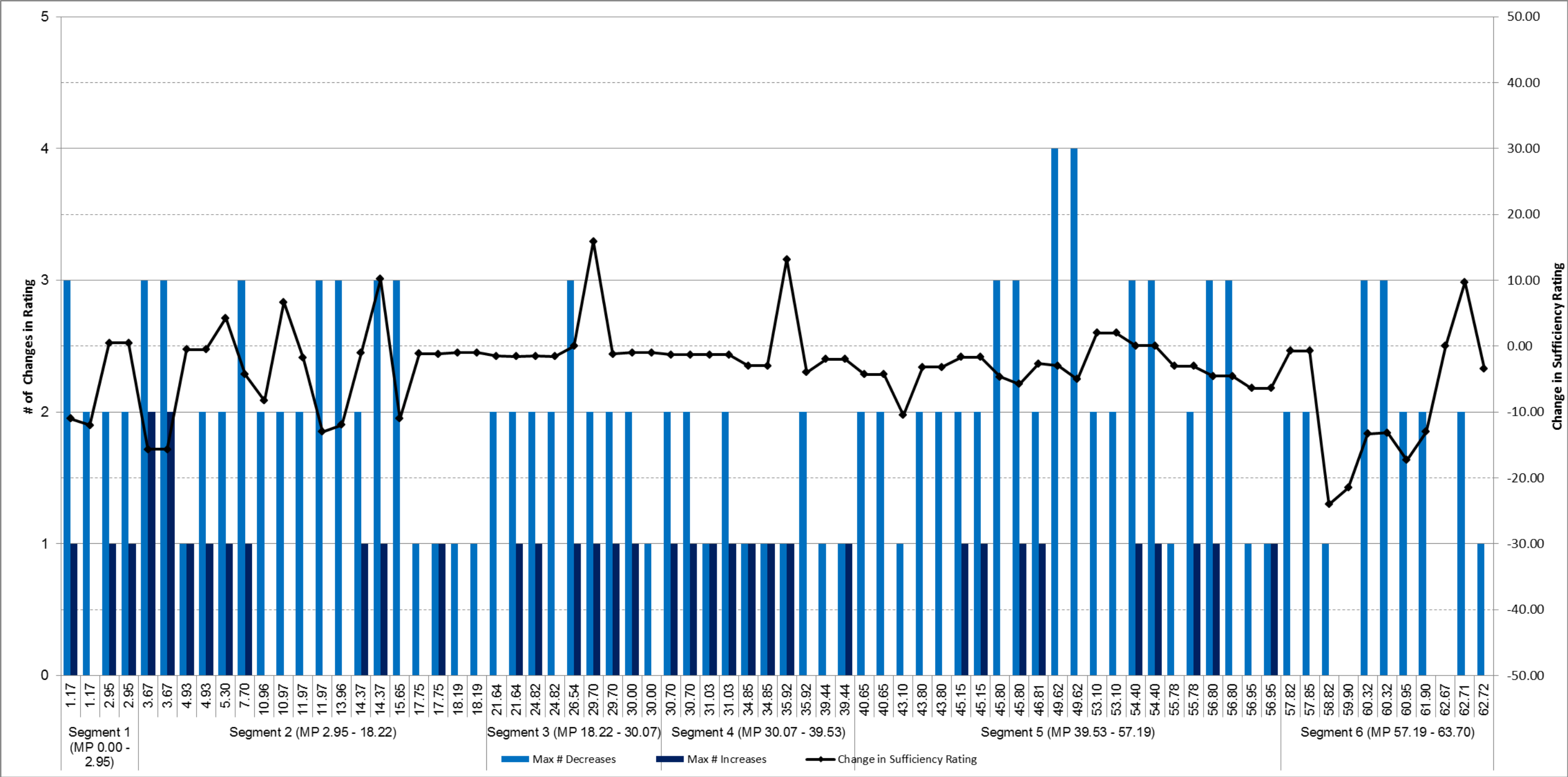
Functionally Obsolete Bridges

The locations of functionally obsolete bridges are also listed in **Table 6**. While the functionally obsolete performance and deficiency is documented in **Table 5**, the measure was removed from the deficiency assessment (resulting in a lower level of deficiency) since being functionally obsolete does not typically result in rehabilitation.

Previous Projects

Previous projects which would supersede the bridge condition data are listed in **Table 6**. In Step 2, this information was used to lower or eliminate deficiencies on segments where recent rehabilitation projects have been completed. In segment 19-6, multiple bridge structures have been identified for reconstruction, but the projects have not yet been implemented.

Table 5: Initial Bridge Deficiencies (Step 1)

Segment	Segment Mileposts	Segment Length (miles)	# Bridges/ Segment	Bridge Index			Bridge Rating			Bridge Sufficiency			% Functionally Obsolete Bridges			Initial Deficiency
				Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	
19-1	0-3	3	4	5.98	Fair or Better	Low	5	Fair or Better	Medium	90.03	Fair or Better	None	100.00%	Fair or Better	High	Medium
19-2	3-18	15	18	5.97	Fair or Better	Low	5	Fair or Better	Medium	89.70	Fair or Better	None	23.29%	Fair or Better	None	Low
19-3	18-30	12	9	6.18	Fair or Better	None	6	Fair or Better	None	93.08	Fair or Better	None	19.73%	Fair or Better	None	None
19-4	30-40	9	10	6.60	Fair or Better	None	6	Fair or Better	None	95.35	Fair or Better	None	15.72%	Fair or Better	None	None
19-5	40-57	18	21	5.30	Fair or Better	Medium	4	Fair or Better	High	90.92	Fair or Better	None	21.33%	Fair or Better	None	High
19-6	57-64	7	11	6.10	Fair or Better	None	5	Fair or Better	Medium	77.74	Fair or Better	None	18.84%	Fair or Better	None	Low
Weighted Average				5.91	Fair or Better	Low										

Figure 5: Bridge History

Maximum # Decreases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating decreased from 1997 to 2014. (Higher number could indicate a more dramatic decline in the performance of the bridge)

Maximum # Increases: Maximum number of times that the Deck Rating, Substructure Rating, or Superstructure Rating increased from 1997 to 2014. (Higher number could indicate a higher level of investment)

Change in Sufficiency Rating: Cumulative change in Sufficiency Rating from 1997 to 2014. (Bigger negative number could indicate a more dramatic decline in the performance of the bridge)

Table 6: Refined Bridge Deficiencies (Step 2)

Segment	Segment Mileposts (MP)	Segment Length (miles)	# Bridges/ Segment	Initial Deficiency	Deficiency Adjustments				Refined Deficiency	Comments (may include programmed projects or issues from previous reports)
					Hot Spots (Rating of 4)	Historical Review	# Functionally Obsolete Bridges	Previous Projects (supersedes condition data)		
19-1	0-3	3	4	Medium	-	1 Western Ave TI OP NB	4	No recent projects	Medium	Western Ave TI OP SB has also been identified for review due to low current performance ratings. No bridges listed for review have been identified for a future project.
19-2	3-18	15	18	Low	-	7 Pajarito Rd OP NB Pajarito Rd OP SB Ruby Road TI UP Agua Fria Cyn Br SB Peck Canyon TI UP Peck Cyn Wash BR SB Palo Parado TI UP	3	No recent projects	Medium	Rio Rico EB TI UP and Agua Fria Cyn Br NB have also been identified for review due to low current performance ratings. Of the identified bridges (Historical Review or Low Performance), the Rio Rico Drive TI, Peck Canyon TI, Peck Canyon Wash Bridge, and the Palo Parado TI were listed for improvements in the Unified Nogales Santa Cruz County Transportation Plan. The refined deficiency of this segment has been increased to Medium from Low based on the percentage of the bridges being identified for review.
19-3	18-30	12	9	None	-	1 Agua Linda UP	0	No recent projects	Low	No project has been identified for any future projects in this segment. Level of deficiency has been increased to Low due to the presence of 1 bridge being identified for historical review.
19-4	30-40	9	10	None	-	-	2	No recent projects	None	No bridges with current ratings less than 6 and no historical issues with ratings
19-5	40-57	18	21	High	6 El Toro Rd OP NB El Toro Rd OP SB Pima Mine TI OP NB Pima Mine TI OP SB Santa Cruz Riv Br NB Santa Cruz Riv Br SB	8 El Toro Rd OP NB El Toro Rd OP SB Pima Mine TI OP NB Pima Mine TI OP SB Papago Res TI OP NB Papago Res TI OP SB Santa Cruz Riv Br NB Santa Cruz Riv Br SB	8	No recent projects	High	Helmut Peak TI UP has also been identified for review due to low current performance ratings. Of the bridges identified, El Toro Rd OP SB & NB Bridge Deck Rehabilitation has been programmed in the ADOT 5 year program in FY 16; Helmet Road TI has been identified for reconstruction in the PAG SE Area Study and the PAG 2040 Regional Transportation Plan; Pima Mine TI SB & NB has been programmed in the ADOT 5 year program in FY 16; Papago Res TI SB & NB has been identified for reconstruction in the I-19 Corridor Study (I-10 to Pima/Santa Cruz Line); Santa Cruz River Bridge SB & NB has been identified for Bridge Deck Rehabilitation in the ADOT 5 year program in FY 16.
19-6	57-64	7	11	Low	-	4 Valencia Road TI UP Drexel Road UP Airport Wash Br NB Airport Wash Br SB	2	No recent projects	Medium	Irvington Rd TI UP and Ajo Way UP have also been identified for review due to low current performance ratings. Of the bridges identified, Drexel Rd UP and the Irvington Rd TI have been listed for reconstruction in the I-19 San Xavier Road to I-10 Final DCR (2012); the Ajo Way TI and Irvington Rd TI have been identified for reconstruction in the ADOT 5 year program for FY 18 and FY 19 respectively. The refined deficiency of this segment has been increased to Medium from Low based on over 50% of the bridges being identified for review.

4.3   Step 3: Bridge Contributing Factors

The Refined Deficiencies for the I-19 corridor were further investigated as described in Section 2.3. Each bridge was investigated to identify any contributing factors for current ratings less than 6 (Deck, Superstructure, Substructure, or Structural Elevation Rating). Bridge inspection reports were then collected for the bridges that were identified with possible historical rating concerns so as to investigate potential repetitive issues. A summary of this process is shown in **Table 7**.

Final Deficiencies

The Final Deficiency level only deviates from the Refined Deficiency if the more detailed analysis in Step 3 revealed that a repetitive investment issues did not exist (which would decrease the deficiency level).

One change in the final deficiency occurred in segment 19-5 where three of the nine bridges reviewed where determined to have no recurring investment issue which resulted in a decrease in deficiency level to a 'Medium' rating. Additionally, the six bridges identified with an existing deficiency are programmed for rehabilitation in FY 2016.

Table 7: Bridge Contributing Factors (Step 3)

Segment	Segment Mileposts (MP)	Segment Length (Miles)	# Bridges/ Segment	Refined Deficiency	Bridges of Concern / Contributing Factors			Final Deficiency
					Bridge	Current (2014) Ratings	Historical Review	
19-1	0-3	3	4	Medium	Western Ave TI OP NB (#1545) (MP 1.17)	Current Superstructure Rating of 5	This structure is identified as functionally obsolete. It has experienced a shift in substructure and superstructure rating since 2007 due to spalling and abutment cracking. The presence of cracking in the T beams' fascia extends between support abutments and were recommended for repair. No projects listed to improve this structure.	Medium
					Western Ave TI OP SB (#1546) (MP 1.17)	Current Superstructure Rating of 5	This structure was not identified for historical review.	
19-2	3-18	15	18	Medium	Pajarito Rd OP NB (#1298) (MP 3.67)	Current Superstructure Rating of 5	This structure is identified as functionally obsolete. It has experienced a shift in superstructure rating since 2007 due to the increase in cracking on the exterior T beams and the underdeck which are showing reflection of the steel bottom reinforcement throughout the soffit area. Recent inspections indicate a recommendation to monitor the vertical cracks in the T-girders. No projects are listed for this structure.	Medium
					Pajarito Rd OP SB (#1299) (MP 3.67)	Current Superstructure Rating of 5	This structure is identified as functionally obsolete. It has experienced a shift in superstructure rating since 2007 due to an increase in shear and flexural cracking in exterior T beams. Inspection reports recommend monitoring vertical cracking in both interior and exterior beams. No projects are listed for this structure.	
					Ruby Road TI UP (#1240) (MP 7.70)	All current ratings - 6 or above	After further review, deficiencies were not identified for this structure since it does not appear to have a repetitive investment issue	
					Rio Rico EB TI UP (#933) (MP 10.96)	Current Deck Rating of 5 Current Superstructure Rating of 5	This structure was not identified for historical review.	
					Agua Fria Cyn Br NB (#353) (MP 11.97)	Current Deck Rating of 5 Current Superstructure Rating of 5	This structure was not identified for historical review.	
					Agua Fria Cyn Br SB (#906) (MP 11.97)	Current Deck Rating of 5 Current Substructure Rating of 5 Current Superstructure Rating of 5	This structure has experienced a decrease in deck, super-, and substructure rating since 2004 due to the presence of bare shoulders, reflective cracks, eroding deck fascia and scoured abutments. Scours were recommended for repair in inspection reports in 2008 and 2010. No projects have been identified.	
					Peck Canyon TI UP (#935) (MP 13.96)	Current Superstructure Rating of 5	This structure has experienced a decrease in superstructure rating since 2007 due to cracks in the box girder fascia, spans and soffit. Continued recommendations to repair the spall at the overhang deck on the SE abutment corner have not been completed as recommended. This structure has been listed as recommended for improvement in the Unified Nogales Santa Cruz County Transportation Plan.	
					Peck Canyon Wash SB (#354) (MP 14.37)	All current ratings - 6 or above	This structure has experienced a slight decrease in deck and superstructure rating over time. Historical review does not indicate recommended repairs, however notes an increase in the amount of deck cracking and size of cracks in the superstructure. This structure has been listed as recommended for improvement in the Unified Nogales Santa Cruz County Transportation Plan.	
					Palo Parado Rd (#937) (MP 15.65)	Current Deck Rating of 5 Current Superstructure Rating of 5	This structure has experienced a decrease in deck and superstructure rating since 2004 due to extensive deck, curb and parapet cracks. The east joint seal on the deck was replaced in 2004 and is deteriorating. The west joint seal on the deck is also deteriorating. It has been recommended in multiple past inspection reports to monitor cracking on the exterior box and top deck. This structure has been listed as recommended for improvement in the Unified Nogales Santa Cruz County Transportation Plan.	

Segment	Segment Mileposts (MP)	Segment Length (Miles)	# Bridges/ Segment	Refined Deficiency	Bridges of Concern / Contributing Factors			Final Deficiency
					Bridge	Current (2014) Ratings	Historical Review	
19-3	18-30	12	9	Low	Agua Linda UP (#1739) (MP 26.54)	All current ratings - 6 or above	After further review, deficiencies were not identified for this structure since it does not appear to have a repetitive investment issue. Therefore the level of deficiency for this segment has been decreased to 'None'.	None
19-4	30-40	9	10	None	None	N/A	N/A	None
19-5	40-57	18	21	High	El Toro Rd OP NB (#1572) (MP 45.80)	Current Deck Rating of 4	This structure is identified as structurally deficient and has experienced a significant decrease in deck rating over time. Past inspection reports have recommended the rehabilitate the bridge deck, and repair cracks and spalls in approach slabs. This structure has been identified for a Bridge Rehabilitation project in FY 16 in the ADOT 5 year program.	Medium
					El Toro Rd OP SB (#1573) (MP 45.80)	Current Deck Rating of 4	This structure is identified as structurally deficient and has experienced a significant decrease in deck rating over time. Past inspection reports have recommended to rehabilitate the bridge deck. This structure has been identified for a Bridge Rehabilitation project in FY 16 in the ADOT 5 year program.	
					Helmut Peak TI UP (#1356) (MP 46.81)	Current Deck Rating of 5	This structure was not identified for historical review.	
					Pima Mine TI OP NB (#1303) (MP 49.62)	Current Deck Rating of 4	This structure is identified as structurally deficient and has experienced a significant decrease in deck rating over time due to numerous small and large AC patched and unpatched spalls. Past inspection reports have recommended to rehabilitate the bridge deck. This structure has been identified for a Bridge Rehabilitation project in FY 16 in the ADOT 5 year program.	
					Pima Mine TI OP SB (#1304) (MP 49.62)	Current Deck Rating of 4	This structure is identified as structurally deficient and has experienced a significant decrease in deck rating over time due to large random cracks and extensive small and large AC patched and unpatched spalls. Previous repairs are deteriorating. Past inspection reports have recommended to rehabilitate the bridge deck. This structure has been identified for rehabilitation in FY 16 in the ADOT 5 year program.	
					Papago Res TI OP NB (#1307) (MP 54.40)	All current ratings - 6 or above	After further review, deficiencies were not identified for this structure since it does not appear to have a repetitive investment issue	
					Papago Res TI OP SB (#1308) (MP 54.40)	All current ratings - 6 or above	After further review, deficiencies were not identified for this structure since it does not appear to have a repetitive investment issue	
					Santa Cruz Riv Br NB (#1243) (MP 56.80)	Current Deck Rating of 4	This structure is identified as structurally deficient and has experienced a significant decrease in deck rating over time due to ineffective patching, the presence of extensive cracking, and other failed repairs over time. Past inspection reports have recommended to rehabilitate the top deck. This structure has been identified for a Bridge Rehabilitation project in FY 16 in the ADOT 5 year program.	
					Santa Cruz Riv Br SB (#1244) (MP 56.80)	Current Deck Rating of 4	This structure is identified as structurally deficient and has experienced a significant decrease in deck rating over time due to ineffective patching, the precense of extensive cracking, and other failed repairs over time. Past inspection reports have recommended to rehabilitate the top deck, to straighten the bent stiffener at girder 5, the repair multiple cracked welds, and repair the south embankment in front of the abutment. This structure has been identified for a Bridge Rehabilitation project in FY 16 in the ADOT 5 year program.	
19-6	57-64	7	11	Medium	Valencia Rd TI UP	All current ratings - 6 or above	This structure was not identified for historical review.	Medium
					Drexel Rd UP	Current Deck Rating of 5	This structure was not identified for historical review.	
					Airport Wash Br NB (#1121) (MP 60.32)	Current Deck Rating of 5 Current Superstructure Rating of 5	This structure has decreased in deck and superstructure rating over time due to extensive random cracks with spalls and pop outs in addition to cracks in the soffit. Previously recommended repairs were not complete. Inspection reports in 2011 and 2013 recommend the rehab of the top deck surface as a priority item. No improvement has been made and no projects for this structure are programmed or proposed.	
					Airport Wash Br SB (#1122) (MP 60.32)	Current Deck Rating of 5 Current Superstructure Rating of 5	This structure has decreased in deck and superstructure rating over time due to extensive map cracking throughout the deck area and medium to large cracks in the soffit. Previously recommended repairs were not complete. Inspection reports in 2011 and 2013 recommend the rehab of the top deck as a priority item. No improvement has been made and no projects for this structure are programmed or proposed.	
					Irvington Rd TI UP	Current Deck Rating of 5 Current Superstructure Rating of 5	This structure was not identified for historical review however it is recommended for reconstruction in the I-19 San Xavier Road to I-10 Final DCR (2012) and as part of the PAG TIP for FY 19.	
					Ajo Way UP	Current Deck Rating of 5	This structure was not reviewed, but is programmed for TI reconstruction in FY 18.	

5 MOBILITY PERFORMANCE AREA NEEDS

The following sections describe the needs assessment process for the I-19 corridor for the Mobility Performance Area.

5.1 Step 1: Initial Mobility Deficiencies

The baseline performance data and performance objectives for the I-19 corridor were used to determine the initial deficiencies as described in Section 2.1. The performance scores, objectives and initial deficiencies for each mobility performance measure are shown in **Table 8.**

This table forms the baseline for subsequent steps in the needs assessment in which potentially modifying information is examined. The initial deficiency is based directly on the performance score and may be modified in steps 2 and 3 based on recently completed, planned or programmed projects that have or will improve mobility performance, and on direct input from ADOT Districts or other data management units.

Segments 19-1 and 19-3 report a high level of deficiency in the northbound Travel Time Index and Planning Time Index. Segment 19-6 reports a high level of deficiency in the primary Mobility Index, which is based on existing and projected future traffic volumes as described in Working Paper #2. **Appendix A** defines the detailed calculations used to determine the initial mobility deficiency levels.

Table 8: Initial Mobility Deficiencies (Step 1)

Segment	Segment Mileposts	Segment Length (miles)	Mobility Index			Future Daily V/C			Existing Peak Hour V/C						Closure Extent (occurrences/year/mile)				
			Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	Performance Score		Performance Objective	Level of Deficiency		Performance Score		Performance Objective	Level of Deficiency	
									NB	SB		NB	SB	NB	SB		NB	SB
19-1	0-3	3	0.23	Fair or Better	None	0.28	Fair or Better	None	0.17	0.17	Fair or Better	None	None	0.27	0.27	Fair or Better	None	None
19-2	3-18	15	0.46	Fair or Better	None	0.56	Fair or Better	None	0.28	0.30	Fair or Better	None	None	0.30	0.20	Fair or Better	None	None
19-3	18-30	12	0.37	Fair or Better	None	0.45	Fair or Better	None	0.21	0.23	Fair or Better	None	None	0.11	0.19	Fair or Better	None	None
19-4	30-40	9	0.40	Fair or Better	None	0.48	Fair or Better	None	0.27	0.28	Fair or Better	None	None	0.25	0.20	Fair or Better	None	None
19-5	40-57	18	0.66	Fair or Better	None	0.77	Fair or Better	None	0.51	0.48	Fair or Better	None	None	0.29	0.23	Fair or Better	None	None
19-6	57-64	7	1.04	Fair or Better	High	1.25	Fair or Better	High	0.90	0.76	Fair or Better	Medium	None	0.31	0.34	Fair or Better	None	None
Weighted Average			0.54	Good	None													

Segment	Segment Mileposts	Segment Length (miles)	Directional TTI (all vehicles)				Directional PTI (all vehicles)				Initial Deficiency
			Performance Score		Performance Objective	Level of Deficiency	Performance Score		Performance Objective	Level of Deficiency	
			NB	SB		NB	SB	NB	SB	NB	SB	
19-1	0-3	3	1.40	1.01	Fair or Better	High	None	2.28	1.30	Fair or Better	High	None	Low
19-2	3-18	15	1.16	1.13	Fair or Better	None	None	1.25	1.22	Fair or Better	None	None	None
19-3	18-30	12	1.58	1.10	Fair or Better	High	None	2.50	1.17	Fair or Better	High	None	Low
19-4	30-40	9	1.06	1.06	Fair or Better	None	None	1.08	1.12	Fair or Better	None	None	None
19-5	40-57	18	1.06	1.08	Fair or Better	None	None	1.11	1.15	Fair or Better	None	None	None
19-6	57-64	7	1.00	1.04	Fair or Better	None	None	1.03	1.14	Fair or Better	None	None	High

5.2 Step 2: Refined Mobility Deficiencies

The Initial Deficiencies for the I-19 corridor were refined as described in Section 2.2. In order to obtain a more complete level of understanding for each segment, the data were further analyzed to determine if high levels of weekend traffic would increase the level of deficiency or if any recently completed projects within the study area segments address the identified. Refined levels of deficiency are summarized for the Mobility Performance Area in **Table 9**.

Weekend Traffic Volume

Using data from permanent count locations along I-19, the daily traffic volumes for weekend days (Friday through Sunday) throughout one calendar year were tabulated. These daily weekend traffic volumes were compared to the threshold volumes necessary for the Primary Mobility Index calculation (defined in Working Paper #2) to result in 'Poor' performance. If the total number weekend days where the daily traffic volumes resulted in a 'Poor' Mobility Performance Index more than 17% of the time, the level of deficiency was increased one level. If the number of days resulting in a 'Poor' Mobility Index score was more than 33% of the time, the level of deficiency was increased two levels. The I-19 corridor has only two segments with permanent counters, so

the results are less robust than the ideal situation. However, the results do show high daily weekend traffic volumes that result in poor mobility in segment 19-6, the Tucson urban area.

Recently Completed and Under-Construction Mobility Projects

ADOT provided information on recently completed and under construction projects since 2013 which was used to modify deficiencies reported on each segment. No recently completed projects were noted in the corridor that would improve the initial deficiency level.

Planned or Programmed Projects

ADOT also provided information on planned and programmed projects through the ADOT Five-Year Facilities Construction Program. This program identifies several significant capacity and interchange improvements programmed for construction in the immediate future in segment 19-6. Those projects are not yet completed, and while the improvements can be expected to significantly improve congestion in the future, the refined deficiency remains 'High' until project completion.

The I-19/Mariposa TI is also planned for reconfiguration, which would improve conditions in segment 19-1. However, funds for that project are not programmed at this time.

Table 9: Refined Mobility Deficiencies (Step 2)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Initial Deficiency	Deficiency Adjustments		Refined Deficiency	Planned and Programmed Future Projects
				% of Weekend Traffic (Fri-Sun) Volumes Resulting in Poor Mobility Index	Recent Projects Since 2013		
19-1	0-3	3	Low	No Data	None	Low	Planned I-19, I-19B Terminus to West Street - Roadway Improvements for Future Capacity I-19 and Mariposa TI reconfiguration
19-2	3-18	15	None	No Data	None	None	Planned I-19, SR 189/Mariposa Road TI to Tumacocori TI – Roadway Improvements for Future Capacity I-19, Exit 22 (Peck Canyon Rd) to Exit 48 (Arivaca Road) – Interchange Improvements
19-3	18-30	12	Low	0%	None	Low	Programmed (FY 2015) Canoa Shoulders - Construct Shoulder Widening
19-4	30-40	9	None	No Data	None	None	Nothing planned or programmed in this segment
19-5	40-57	18	None	No Data	None	None	Planned Esperanza, Duval Mine Rd, Helmet Peak, Pima Mine Rd, Papago TI reconstruction projects listed in various planning documents Capacity expansion planned entire segment listed in various planning documents
19-6	57-64	7	High	81%	None	High	Programmed Ajo Way TI - Reconstruct TI and Mainline (2015, 2018) Irvington Road and I-19 – Design and reconstruct new TI (2019) Planned Capacity expansion planned entire segment listed in various planning documents All interchanges planned for upgrade Reconstruct I-19 to four lanes in each direction between San Xavier Road and I-10 (I-19 DCR)

5.3   Step 3: Mobility Contributing Factors

The refined deficiencies for the I-19 corridor were further investigated as described in Section 2.3. Several variables that contribute to capacity and Level of Service (LOS) calculations were isolated for the analysis to determine their effect on deficiencies. These isolated variables are not considered to increase or decrease the refined deficiency, but do provide more information about the factors affecting performance and ultimately what types of improvements could be considered to improve performance.

Roadway and traffic variables that were not used as part of LOS calculations and helped to further define contributing factors include roadway characteristics such as the presence of auxiliary lanes, divided/non-divided highway, sustained grades, and locations of passing lanes. In addition, traffic characteristics including percent (%) trucks, weekend traffic volumes, and the PTI/TTI buffer index were also analyzed. Furthermore, general corridor characteristics such as mobility related infrastructure and non-actionable conditions were also summarized to understand their impact to segment mobility deficiencies. A summary of the results of this process is shown in **Table 10**.

Roadway Variables

The presence of auxiliary lanes between traffic interchanges, divided/non-divided highway designations, sections of sustained grades, and location of passing lanes can all impact the overall mobility and traffic flow of sections of interstate and highway corridors.

- Lack of auxiliary lanes can decrease mobility performance by slowing traffic and increasing congestion.
- Divided vs. non-divided highways will impact how LOS is calculated and determine acceptable performance thresholds.
- Sections of highway/interstate with sustained grades will impact the overall speed of a corridor and affect travel time.
- Presence of passing lanes will impact how LOS is calculated.

Traffic Variables

The number of trucks that travel a corridor, the difference in the calculated Planning Time Index (PTI) and Travel Time Index (TTI), and the comparison between weekend and weekday traffic volumes all indicate how well a corridor is performing in terms of overall mobility and why certain sections of a corridor may be performing worse than others.

Truck Traffic

The amount of truck traffic in a given segment of the I-19 corridor was determined using the most recent Highway Performance Monitoring System (HPMS) data from ADOT. The truck volume on a segment is represented as a percentage of the overall total traffic volume for a specific segment. The truck volume on a corridor can impact overall mobility based on truck travel speed, corridor grades, required inspection points, and total distance.

PTI/TTI Buffer Index

The PTI and TTI Buffer Index is calculated by subtracting the segment level TTI value (ratio of peak hour speed to free flow speed) from the segment level PTI value (95th percentile speed)

which are determined in Working Paper #2. The resulting number represents the buffer time index which expresses the amount of extra time necessary to be on-time 95 percent of the time for any given trip. This calculation provides information on the reliability of a corridor, not the level of congestion.

Weekday and Weekend Traffic Volumes

Similar to Step 2, the number of weekend days (Fri-Sun) where the total traffic volume results in a 'Poor' Mobility Index score was calculated. As part of the Step 3 refined analysis, this number was compared against the total number of weekdays (Mon-Thurs) that also result in a 'Poor' Mobility Index score. This comparison provides insight about segments that consistently score as 'Poor' in the Mobility Index or if traffic volume increase occur solely on the weekend or during the week.

Mobility Related Infrastructure

Mobility related infrastructure refers to corridor characteristics that are important to identify and understand and that may be a factor in performance. Mobility related infrastructure refers to characteristics that are not consistent throughout a segment such as sections hat are not fully divided or portions of segments that have more travel lanes. These characteristics can impact the mobility performance of a segment, but may be overlooked at the segment level.

Non-Actionable Conditions

Non-actionable conditions are characteristics of a segment that result in poor mobility performance that cannot be addressed through an engineered solution. The presence of non-actionable conditions should result in the improvement of segment level deficiency since they cannot be addressed.

Contributing Factors

Mobility deficiencies remain fairly low for the I-19 corridor in comparison with other major corridors in Arizona. The contributing factors column in Table 10 helps identify relevant concerns. Of note, Segment 19-6 exhibits congested urban corridor characteristics such as high weekday peak hour volumes resulting from workers entering the city for employment, high weekend volumes resulting from residents seeking activities away from home, and a high number of road closures resulting from traffic accidents.

Final Deficiencies

After reviewing all of the information provided in Step 3, a Final Deficiency level was determined for each segment. This deficiency level only deviates from the Refined Deficiency if the more detailed analysis of Step 3 identified a mobility performance issue (which would increase or decrease the deficiency level). For I-19, the deficiency level of segment 19-1 and 19-3 was decreased to 'None' due to the presence of a non-freeway urban section and a border patrol checkpoint, respectively. The deficiency level remained unchanged for all other segments of I-19. **Table 10** summarizes the outcome of Step 3.

Table 10: Mobility Contributing Factors (Step 3)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Refined Deficiency	Roadway Variables									Traffic Variables						
				Functional Classification	Environment Type (Urban/Rural)	Terrain	# of Lanes Each Direction	Speed Limit	Aux Lanes	Divided/ Non-Divided	Sustained Grades	% No Passing	Existing LOS	Future LOS (2035)	% Trucks	NB Buffer Index (PTI-TTI)	SB Buffer Index (PTI-TTI)	% Weekdays (Mon-Thurs) with Existing Traffic Volumes that result in Poor Mobility Index	% Weekends (Fri-Sun) with Existing Traffic Volumes that result in Poor Mobility Index
19-1	0-3	3	Low	Interstate	Fringe Urban	Rolling	2	25-65	None	Both	No	0%	A-C	A-C	7%	0.88	0.29	No Data	No Data
19-2	3-18	15	None	Interstate	Rural	Level	2	75	None	Divided	No	0%	A-C	A-C	8%	0.09	0.09	No Data	No Data
19-3	18-30	12	Low	Interstate	Rural	Level	2	75	None	Divided	No	0%	A-C	A-C	11%	0.92	0.06	0%	0%
19-4	30-40	9	None	Interstate	Fringe Urban	Level	2	65-75	None	Divided	No	0%	A-C	A-C	13%	0.03	0.06	No Data	No Data
19-5	40-57	18	None	Interstate	Fringe Urban	Level	2	65-75	None	Divided	No	0%	A-C	D	14%	0.05	0.07	No Data	No Data
19-6	57-64	7	High	Interstate	Urban	Level	2	55-65	None	Divided	No	0%	A-C	E/F	7%	0.03	0.10	93%	81%

Segment	Segment Mileposts (MP)	Segment Length (miles)	Refined Deficiency	Closure Extent				Relevant Mobility Related Existing Infrastructure	Non-Actionable Conditions	Contributing Factors	Final Deficiency
				Total Number Closures	% Closures (No Reason)	% Incidents/ Accidents	% Obstructions/ Hazards	% Weather Related				
19-1	0-3	3	Low	6	0%	83%	0%	17%	1/4 mile non-divided in Nogales	1/4 mile of Non-freeway urban section	• Urban portion of I-19 within Nogales, beginning as a low-speed non-divided cross-section and transitioning to a higher-speed controlled access 4-lane interstate. • Existing and future traffic LOS is good, but the urban environment and rolling terrain may contribute to accident and weather-related closures. • High deficiencies in northbound TTI and PTI are related to lower speed limits on the non-divided section.	None
19-2	3-18	15	None	30	0%	97%	3%	0%	None	None	• Elevated incident/accident-related closures not sufficient to lower the TTI/PTI, but may be associated with periodic congestion at I-19/US 189 TI.	None
19-3	18-30	12	Low	9	0%	78%	22%	0%	None	Border Checkpoint in NB direction	• Elevated northbound TTI/PTI deficiency related to Border Patrol checkpoint near Tubac causes temporary delays and slower average speeds for length of segment. Non-actionable condition. • 78% of closures related to incidents/accidents.	None
19-4	30-40	9	None	12	8%	83%	8%	0%	None	None	• No reported performance deficiencies. • 83% of closures incidents/accidents-related.	None
19-5	40-57	18	None	42	0%	100%	0%	0%	None	None	• Elevated number of closures 100% incident/accident-related • Multiple TI and ramp improvement projects planned for near-term to maintain LOS and reduce accidents.	None
19-6	57-64	7	High	21	33%	67%	0%	0%	3 lanes each direction between Ajo TI and I-10	None	• High Mobility Index performance deficiency, based on heavy NB flows entering Tucson urban area. • Congested levels existing peak hour V/C and future daily V/C. • The number of weekdays vs. weekend days in which traffic volumes exceed acceptable LOS are nearly equal. There is no spike in traffic that can be attributed to week day or weekend traffic. • 67% of closures are accidents-related, with 33% unidentified. May be related to increased congestion in urban area.	High

6   SAFETY PERFORMANCE AREA NEEDS

This chapter presents an overview of deficiencies for the Safety Performance Area generated from Steps 1-3 of the Needs Assessment Process. The methodology for performing Steps 1-3 is provided in the Appendix.

6.1   Step 1: Initial Safety Deficiencies

The baseline performance data and performance objectives for the I-19 corridor Safety Performance Area were used to determine the Initial Deficiencies as described in Section 2.1. The safety data used to calculate baseline performance was provided by ADOT for the timeframe from 2009 to 2013.

Step 1 uses the Safety Index primary performance measure and two of the secondary safety performance measures (Strategic Highway Safety Plan (SHSP) Top 5 Emphasis Area Behaviors

and Truck-Involved Crashes). The two other secondary safety performance measures (Motorcycle-Involved Crashes and Non-Motorized Crashes) exhibited small crash sample sizes in their entirety and were not considered in the Safety Performance Deficiency assessment (refer to sample size criteria documented in Working Paper 2: Baseline Corridor Performance). Corridor segments that exhibited small crash sample sizes for the SHSP Top 5 Emphasis Area Behaviors and Truck-Involved Crashes were also excluded from the deficiency assessment. The Safety Performance Area Initial Deficiencies for the I-19 corridor segments are shown in **Table 11.**

No segments on I-19 show an initial deficiency in the high range. The overall Safety Index shows a low score on segment 19-1 and results in an initial deficiency of Medium. Segment 19-5 also scores Medium in the initial deficiency column. **Appendix A** defines the detailed calculations used to determine the initial safety deficiency levels.

Table 11: Initial Safety Deficiencies (Step 1)

Segment	Segment Mileposts	Segment Length (miles)	Safety Index			% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors			% of Fatal + Incapacitating Injury Crashes Involving Trucks			Initial Deficiency
			Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	
19-1	0-3	3	0.77	Fair or Better	Medium	Insufficient Data	Fair or Better	Unknown	Insufficient Data	Fair or Better	Unknown	Medium
19-2	3-18	15	1.13	Fair or Better	None	68%	Fair or Better	Low	16%	Fair or Better	None	Low
19-3	18-30	12	1.42	Fair or Better	None	50%	Fair or Better	None	10%	Fair or Better	None	None
19-4	30-40	9	1.12	Fair or Better	None	61%	Fair or Better	Medium	17%	Fair or Better	None	Low
19-5	40-57	18	0.95	Fair or Better	Medium	43%	Fair or Better	None	16%	Fair or Better	None	Medium
19-6	57-64	7	1.27	Fair or Better	None	61%	Fair or Better	None	22%	Fair or Better	None	None
Weighted Average			1.13	Good	Low							

6.2   Step 2: Refined Safety Deficiencies

The Safety Performance Area Initial Deficiencies for the I-19 corridor were refined as described in Section 2.2. Step 2 used the location of crash hot spots as well as relevant recently completed and under-construction projects to refine the deficiencies for each segment. The Safety Performance Area Refined Deficiencies for the I-19 corridor segments are shown in **Table 12**.

Crash Hot Spots

Directional crash concentration locations (known as "hot spots"), as determined in the baseline safety performance evaluation, were categorized as Large, Medium, or Localized based on the number of crashes within each respective hot spot. Crash hot spots were assigned to the appropriate segment(s) of I-19. Large and Medium crash hot spots were considered justification for increasing (i.e., worsening) the level of deficiency in the corresponding corridor segment.

Recently Completed and Under-Construction Safety Projects

The ADOT *Program Budget Transaction Detail*, input from the ADOT Tucson District, and ADOT public construction notices facilitated identification of recently completed and under-construction projects relevant to safety that have been completed since 2013. Each completed project was assigned to the appropriate segment of I-19. Projects including items such as new or upgraded guardrail, new rumble strips, bridge deck rehabilitation, sign rehabilitation, and pavement rehabilitation were considered to potentially be safety-related. The type of project improvement was compared to the location of crash hot spots to determine if it appeared the project improvement likely would at least partially address the identified safety deficiency. If it appeared there was a high likelihood that the project improvement would at least partially address the identified deficiency, the level of deficiency was decreased (i.e., improved).

Programmed Projects

Table 12 also includes information on safety-related programmed projects. While programmed projects did not influence the level of deficiency, they were documented for future reference during the development of solutions to address identified needs and deficiencies. Programmed projects were identified using the tentative *2016-2020 Current Five-Year Transportation Facilities Construction Program* and approved *2015-2019 State Transportation Improvement Program.*

One adjustment was made during Step 2 on segment 19-5, where six hot spots are documented. Several projects are planned, but not programmed, that could help alleviate some of these safety issues. Therefore, the deficiency in segment 19-5 was refined upward from Medium to High.

6.3   Step 3: Safety Contributing Factors

The Safety Performance Area Refined Deficiencies for the I-19 corridor were further investigated as described in Section 2.3. Step 3 consisted of detailed analysis of the crash data used to quantify the safety performance of I-19. The crash data provides detailed information on the fatal and incapacitating injury crashes that occurred on the I-19 mainline in the period 2009-2013. See **Table 13**.

Table 12: Refined Safety Deficiencies (Step 2)

Segment	Segment Mileposts (MP)	Segment Length (Miles)	Initial Deficiency	Deficiency Adjustments		Refined Deficiency	Programmed Projects
				Hot Spots Size (# Crashes) MP	Recently Completed or Under Construction Projects (supersedes performance data)		
19-1	0-3	3	Medium	Localized (0) NB 9.48-9.7	Pavement preservation from MP 0 - MP 6	Medium	None
19-2	3-18	15	Low	None	None	Low	Planned I-19/Grand Avenue Partial Interchange – Interchange Improvement I-19 "The Curve", Safety Corridor Improvements I-19, Exit 22 (Peck Canyon Rd) to Exit 48 (Arivaca Road) – Interchange Improvements I-19, Tumacocori to Tubac Wildlife Preservation Crossings
19-3	18-30	12	None	None	None	None	None
19-4	30-40	9	Low	Medium (3) NB 30.39-31.33 Medium (3) NB 33.05-34.08 Low (2) NB 38.88-39.79	None	Low	Programmed (FY 2015) Canoa Shoulders - Construct Shoulder Widening (FY 2019) Pavement Preservation MP 32-43
19-5	40-57	18	Medium	Medium (3) NB 43.06-43.87 Medium (3) NB 44.77-45.57 Large (6) NB 53.40-54.46 Medium (3) NB 55.15-56.14 Medium (5) SB 47.64-48.69 Localized (1) SB 54.43-54.73	None	High	Planned Esperanza, Duval Mine Rd, Helmet Peak, Pima Mine Rd, Papago TI reconstruction projects listed in various planning documents Capacity expansion planned entire segment listed in various planning documents
19-6	57-64	7	None	Medium (3) NB 58.05-58.81 Medium (4) NB 59.85-60.50 Large (7) NB 61.74-62.76 Medium (3) SB 61.59-62.10	None	Medium	Programmed Ajo Way TI - Reconstruct TI and Mainline (2015, 2018) Reconstruct I-19 to four lanes in each direction between San Xavier Road and I-10 (I-19 DCR) Irvington Road and I-19 – Design and reconstruct new TI (SPUI) Planned Capacity expansion planned entire segment listed in various planning documents All interchanges planned for upgrade

Segment Crash Type Summaries

The crash data was used to populate the following six crash type summaries for each of the segments of I-19 (possible crash type descriptors are listed for each crash type summary).

- First Harmful Event Type
  - Collision with Motor Vehicle
  - Overturning
  - Collision with Pedestrian
  - Collision with Pedalcyclist
  - Collision With Animal
  - Collision with Fixed Object
  - Collision with Non-Fixed Object
  - Vehicle Fire or Explosion
  - Other Non-Collision
  - Unknown
- Collision Type
  - Single Vehicle Collisions
  - Angle
  - Left Turn
  - Rear End
  - Head On
  - Sideswipe (same)
  - Sideswipe (opposite)
  - Rear to Side
  - Rear to Rear
  - Other
  - Unknown
- Violation or Behavior Type
  - No Improper Action
  - Speed too Fast for Conditions
  - Exceeded Lawful Speed
  - Failure to Yield Right-of-Way
  - Followed Too Closely
  - Ran Stop Sign
  - Disregarded Traffic Signal
  - Made Improper Turn
  - Drove in Opposing Lane
  - Faulty/Missing Equipment
  - Motorcycle Safety Equipment Use
  - Passed in No Passing Zone
  - Unsafe Lane Change
  - Failure to Keep in Proper Lane
  - Other Unsafe Passing
  - Inattention/Distraction
  - Electronic Communications Device
  - Other

- Type of Lighting Conditions
  - Daylight
  - Dawn
  - Dusk
  - Dark-Lighted
  - Dark-Unlighted
  - Dark-Unknown Lighting
- Type of Road Surface Conditions
  - Dry
  - Wet
  - Snow
  - Slush
  - Ice/Frost
  - Water (standing or moving)
  - Sand
  - Mud, Dirt, Gravel
  - Oil
  - Other
  - Unknown
- First Unit Event Description
  - Collision with Animal
  - Collision with Fixed Object
  - Ran Off the Road (Left)
  - Ran Off the Road (Right)
  - Crossed Centerline
  - Crossed Median
  - Collision with Pedestrian
  - Motor Vehicle in Transport
  - Overturn
  - Equipment Failure
  - Collision with Falling Object
  - Other Non-Collision
  - Other Non-Fixed Object
  - Unknown

Crash frequencies for each possible crash type descriptor within each of the six crash type summary categories were summarized by injury severity (fatal, incapacitating injury, and fatal plus incapacitating injury) for each corridor segment that contained at least five crashes of that crash type descriptor (lower crash totals were not considered to have a sufficient sample size for analysis purposes). The proportional occurrence of each possible crash type descriptor compared to the total number of fatal plus incapacitating injury crashes occurring in that respective segment was also calculated and expressed as a percentage. These segment-level crash type descriptor frequency percentages were then compared with the corresponding statewide crash type descriptor frequency percentages for all state highways with similar operating environments (as defined in the baseline corridor performance in Working Paper 2). Segment crash type descriptor frequency percentages that exceeded the corresponding statewide frequency percentage were identified as likely contributing factors to the segment's performance deficiency.

Hot Spot Crash Summaries

Crash summaries were also developed and reviewed for each identified crash hot spot to identify observable crash patterns. Medium and Large crash hot spots had sufficient crash sample sizes to determine if observable crash patterns exist but Localized hot spots did not.

Previously Completed Safety-Related Projects

The ADOT as-built project listing facilitated identification of completed safety-related projects since 2000. Each completed project was assigned to the appropriate segment of I-19. Projects more than five years old may have exceeded their respective design life and may be contributing factors to safety performance deficiencies.

District Input on Safety Concerns

ADOT maintenance personnel in the Tucson Districts provided information on locations where they had safety concerns along I-19. Locations were defined by approximate milepost limits and assigned to the appropriate segment of I-19. District safety concerns that corroborated the segment crash type summaries or hot spot crash summaries were noted.

Contributing Factors

Likely contributing factors to the identified safety performance deficiencies were developed from the segment crash type summaries; hot spot crash summaries, older safety-related projects, and District safety concerns using engineering judgment and Section 6.2 of the *2010 Highway Safety Manual*. These contributing factors provide guidance on the types of solutions that will likely promote improved safety performance.

Final Deficiencies

After reviewing all of the information provided in Step 3, a Final Deficiency level was determined for each segment. This deficiency level would only deviate from the Refined Deficiency if the more detailed analysis of Step 3 identified a previously unknown safety performance issue (which would increase the deficiency level), or identified that there are no observable crash patterns (which would decrease the deficiency level). For I-19, the deficiency level of segment 19-1 was decreased as there were no observable crash patterns. The deficiency level remained unchanged for all other segments of I-19. **Table 13** summarizes the outcome of step 3.

Table 13: Safety Contributing Factors (Step 3)

		19-1	19-2	19-3	19-4	19-5	19-6	Corridor-Wide Fatal & Serious Injury Crashes
Refined Deficiency		Medium	Low	None	Low	High	Medium	
Segment Crash Overview		**2** Crashes were fatal **1** Crashes had incapacitating injuries **0** Crashes involve trucks **0** Crashes involve Motorcycles	11 Crashes were fatal 11 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	3 Crashes were fatal 6 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	6 Crashes were fatal 9 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	19 Crashes were fatal 20 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	7 Crashes were fatal 10 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	48 Crashes were fatal 57 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles
Segment Crash Summaries (Fatal and Serious Injury Crashes)	**First Harmful Event Type**	No crashes occur at a rate higher than the statewide average	23% Involve Collision with Fixed Object	No crashes occur at a rate higher than the statewide average	No crashes occur at a rate higher than the statewide average	36% Involve Collision with Motor Vehicle 15% Involve Collision with Fixed Object	47% Involve Collision with Motor Vehicle	8% Involve Collision with Pedestrian 30% Involve Collision with Motor Vehicle 20% Involve Collision with Fixed Object
	Collision Type	No crashes occur at a rate higher than the statewide average	73% Involve Single Vehicle	56% Involve Single Vehicle	No crashes occur at a rate higher than the statewide average	13% Involve Sideswipe (same) 13% Involve Rear End	35% Involve Rear End	10% Involve Sideswipe (same) 10% Involve Other 14% Involve Rear End
	Violation or Behavior	No crashes occur at a rate higher than the statewide average	23% Involve Other 36% Involve No Improper Action	No crashes occur at a rate higher than the statewide average	47% Involve No Improper Action	15% Involve Failure to Keep in Proper Lane 28% Involve No Improper Action	No crashes occur at a rate higher than the statewide average	15% Involve Other 30% Involve No Improper Action 11% Involve Unknown
	Lighting Conditions	No crashes occur at a rate higher than the statewide average	No crashes occur at a rate higher than the statewide average	56% Occur in Dark-Unlighted Conditions	33% Occur in Dark-Unlighted Conditions	77% Occur in Daylight Conditions	29% Occur in Dark-Lighted Conditions 35% Occur in Dark-Unlighted Conditions	6% Occur in Dark-Lighted Conditions 61% Occur in Daylight Conditions
	Surface Conditions	No crashes occur at a rate higher than the statewide average	95% Involve Dry Conditions	89% Involve Dry Conditions	93% Involve Dry Conditions	95% Involve Dry Conditions	94% Involve Dry Conditions	6% Involve Wet Conditions 91% Involve Dry Conditions
	First Unit Event	No crashes occur at a rate higher than the statewide average	27% Involve a first unit event of Motor Vehicle in Transport	No crashes occur at a rate higher than the statewide average	33% Involve a first unit event of Motor Vehicle in Transport	38% Involve a first unit event of Motor Vehicle in Transport 15% Involve a first unit event of Equipment Failure	59% Involve a first unit event of Motor Vehicle in Transport	38% Involve a first unit event of Motor Vehicle in Transport 16% Involve a first unit event of Equipment Failure 6% Involve a first unit event of Overturn
Hot Spot Crash Summaries		No hot stop crash concentration located in this segment	Hot spot in NB direction from MP 9.48-9.7	No hot stop crash concentration located in this segment	Hot spot located in NB direction from MP 30.39-31.33, 33.05-34.08, and 38.88-39.79	Hot spots located in NB from MP 43.06-43.87; 44.77-45.57; 53.40-54.46; 55.15-56.14 and in SB direction from MP 47.64-48.69; 54.43-54.73	Hot spots lcoated in NB direction from MP 58.05-58.81; 59.85-60.50; 61.74-62.76 and in SB direction from MP 61.59-62.10	
Previoulsy Completed Safety-Related Projects		None	None	None	Ongoing Pavement Preservation MP 31.8-42.5	None	None	
District Interviews/Discussions		pending	pending	pending	pending	High number of fatal crashes near Green Valley. Increased number of crashes due to alcohol from casino patrons	pending	
Contributing Factors		Insufficient Data, deficiency level lowered to NONE	● Single vehicle ● Vehicle in transport	● Single vehicle ● Traffic control device reflectivity	● Traffic control device reflectivity ● Vehicle in transport **Comment:** Canoa Shoulders Widening project may improve safety	● Vehicle in transport ● Improper lane changes ● Higher traffic volume operating conditions ● Urban operating conditions **Comment:** Five interchanges and identified in planning documents for reconstruction/improvements as well as planned added capacity may address safety issues in congested conditions	● Vehicle in transport ● Traffic control device reflectivity ● Improper lane changes ● Higher traffic volume operating conditions ● Urban operating conditions **Comment:** Planned and programmed added capacity and TI reconstruction throughout segment may address safety issues in congested conditions	
Final Deficiency		None	Low	None	Low	High	Medium	

7 FREIGHT PERFORMANCE AREA DEFICIENCIES

This chapter presents an overview of deficiencies for the Freight Performance Area generated from Steps 1-3 of the Needs Assessment Process. The methodology for performing Steps 1-3 is provided in the Appendix.

7.1 Step 1: Initial Freight Deficiencies

Step 1 uses the Freight Performance Index and three secondary performance measures (Directional Truck Travel Time Index (TTTI), Directional Truck Planning Time Index (TPTI), and freeway closure duration). The baseline performance data and performance objectives for the I-19 corridor Freight Performance Area were used to determine the Initial Deficiencies as described in Section 2.1. The data used to calculate baseline performance was provided by ADOT and included:

- The 2013 American Digital Cartography, Inc. HERE (formerly NAVTEQ) provided data for the Truck Travel Time Index (TTTI) and Truck Planning Time Index (TPTI) primary and some of the secondary performance measures.
- The 2009-2013 ADOT Highway Condition Reporting System (HCRS) provided data on the frequency, duration, and extent of full roadway closures.
- The ADOT Intermodal Transportation Department Engineering Permits Section provided data on structures over I-40 with lower vertical clearance values than the minimum standard.

The initial level of performance deficiency for all Freight performance measures and segments are shown in **Table 14.** The I-19 corridor shows High initial deficiencies in segments 19-1 and 19-2, based primarily on the overall Freight Index, the TTTI, and the TPTI. **Appendix A** defines the detailed calculations used to determine the initial freight deficiency levels.

7.2 Step 2: Freight Deficiency Refinement

Step 2 used the location of structures with height restrictions, relevant recently completed and under-construction projects to refine the deficiencies for each segment. The Freight Performance Area Refined Deficiencies for the I-19 corridor segments are shown in **Table 15**. On I-19, all height restricted overpasses can be avoided by ramping the vehicle around the site. The High initial deficiency noted on segment 19-1 does not change as a result of this analysis, given that while capacity and TI improvements are planned, the projects are not programmed for construction. On segment 19-3, the High deficiency has been reduced to None, with the understanding that the US Border Patrol Inspection Station causes slowdowns of an un-actionable nature.

Truck Height Restrictions

In recognition of the commercial traffic on I-19, restrictions to freight travel were obtained from the ADOT Engineering Permits Section. Since weight and width restrictions are provided in the design of interstate infrastructure, only structures with height restrictions were identified along with the availability of ramps that could accommodate oversize vehicle loads.

Recently Completed and Under-Construction Safety Projects

The ADOT *Program Budget Transaction Detail*, input from the ADOT Tucson District, and ADOT public construction notices facilitated identification of recently completed and under-construction

projects relevant to freight that have been completed since 2013. Each completed project was assigned to the appropriate segment of I-19. Projects such as new or upgraded dynamic message signs (DMS) were included.

Programmed Projects

Table 12 also includes information on freight-related programmed projects. While programmed projects did not influence the level of deficiency, they were documented for future reference during the development of solutions to address identified needs and deficiencies. Programmed projects were identified using the tentative *2016-2020 Current Five-Year Transportation Facilities Construction Program* and approved *2015-2019 State Transportation Improvement Program*.

7.3 Step 3: Freight Contributing Causes

The Freight Performance Area Refined Deficiencies for the I-19 corridor were further investigated as described in Section 2.3. Step 3 consisted of detailed analysis of freight-related infrastructure, direction travel time reliability measures (TTTI and TPTI), road closures, and planned/programmed projects. Step 3 information are described below and shown in **Table 16**.

Programmed and Planned Projects or Issues from Previous Documents

The ADOT as-built project listing, programmed projects in the tentative *2016-2020 Current Five-Year Transportation Facilities Construction Program* and approved *2015-2019 State Transportation Improvement Program,* and projects recommended in the ADOT Climbing and Passing Lane Prioritization Study (2015) facilitated identification of completed freight-related projects since 2000. Each completed project was assigned to the appropriate segment of I-19 if applicable.

Directional TTTI and TPTI

HERE data (formerly NAVTEQ) was used to develop directional reliability indices to quantify closure scenarios on I-40 to identify reasons for reliability deficiencies.

Closure Extent

Percent of closures by type were compared to average percentage closures by type on the nine corridors for which Corridor Profile Studies will be conducted (**see Table 13**).

Contributing Factors

Likely contributing factors to the identified freight performance deficiencies were developed using the above described information and engineering judgment. These contributing factors provide guidance on the types of solutions that will likely promote improved freight performance on the I-19 corridor.

Final Deficiencies

After reviewing all of the information provided in Step 3, a Final Deficiency level was determined for each segment. This deficiency level would only deviate from the Refined Deficiency if the more detailed analysis of Step 3 identified a previously unknown freight performance issue (which would increase the deficiency level), or identified that there are no observable freight issues (which would decrease the deficiency level). **Table 16** summarizes the outcome of step 3. Values in red indicate above statewide average.

Table 14: Initial Freight Deficiencies (Step 1)

Segment	Segment Mileposts	Segment Length (miles)	Freight Index			Directional TTI (trucks only)					Directional PTI (trucks only)					Closure Duration (hours/mile/year)			Initial Deficiency
			Performance Score	Performance Objective	Level of Deficiency	Performance Score		Performance Objective	Level of Deficiency		Performance Score		Performance Objective	Level of Deficiency		Performance Score	Performance Objective	Level of Deficiency	
						NB	SB		NB	SB	NB	SB		NB	SB				
19-1	0-3	3	0.46	Fair or Better	High	1.54	1.08	Fair or Better	High	None	2.37	1.96	Fair or Better	High	High	0.97	Fair or Better	None	High
19-2	3-18	15	0.92	Fair or Better	None	1.04	1.04	Fair or Better	None	None	1.09	1.08	Fair or Better	None	None	1.35	Fair or Better	None	None
19-3	18-30	12	0.34	Fair or Better	High	1.43	1.03	Fair or Better	High	None	4.91	1.06	Fair or Better	High	None	1.25	Fair or Better	None	High
19-4	30-40	9	0.95	Fair or Better	None	1.02	1.03	Fair or Better	None	None	1.05	1.06	Fair or Better	None	None	0.90	Fair or Better	None	None
19-5	40-57	18	0.95	Fair or Better	None	1.03	1.03	Fair or Better	None	None	1.05	1.06	Fair or Better	None	None	1.17	Fair or Better	None	None
19-6	57-64	7	0.89	Fair or Better	None	1.02	1.09	Fair or Better	None	None	1.06	1.20	Fair or Better	None	None	4.67	Fair or Better	None	None
Weighted Average			0.80	Good	Low														

Table 15: Refined Freight Deficiencies (Step 2)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Initial Deficiency	Deficiency Adjustments		Refined Deficiency	Programmed Projects/Comments Relevant to Refined Deficiency
				Truck Height Restriction Hot Spots (Clearance < 16')	Recently Completed/Under Construction Projects (supersedes performance data)		
19-1	0-3	3	High	None	None	High	Planned I-19, I-19B Terminus to West Street - Roadway Improvements for Future Capacity I-19 and Mariposa TI reconfiguration
19-2	3-18	15	None	MP 13.96 NB Peak Canyon TI UP- can ramp around	None	None	Planned I-19, SR 189/Mariposa Road TI to Tumacocori TI – Roadway Improvements for Future Capacity I-19 and Mariposa TI reconfiguration US Border Patrol Check Station contributes to slowing traffic, but cannot be mitigated through ADOT action.
19-3	18-30	12	High	MP 26.94 NB Agua Linda TI UP (can ramp around)	None	High	Programmed Project (FY 2015) Canoa Shoulders - Construct Shoulder Widening
19-4	30-40	9	None	None	Installation of truck monitoring and screening systems and weigh-in-motion scales at the Canoa Ranch Rest Area	None	No programmed projects
19-5	40-57	18	None	None	None	None	Programmed (FY2015) Reconstruct the existing ramps in the southbound direction between I-10 and Ajo Way (SR 86), and between Ajo Way and Irvington Road as braided ramps (Phase 1) Programmed Project (FY 2018) Reconstruct the existing partial clover leaf TI at Ajo Way (SR 86) to a SPUI (Phase 2) (2019) Irvington Road and I-19 – Design and reconstruct new TI (SPUI) Planned Esperanza, Duval Mine Rd, Helmet Peak, Pima Mine Rd, Papago TI reconstruction projects listed in various planning documents Capacity expansion planned entire segment listed in various planning documents
19-6	57-64	7	None	MP 60.95 SB Irvington Rd TI UP can ramp around MP 61.90 SB Ajo Way UP (can ramp around)	None	None	Programmed Ajo Way TI - Reconstruct TI and Mainline (2015, 2018) Reconstruct I-19 to four lanes in each direction between San Xavier Road and I-10 (I-19 DCR) Irvington Road and I-19 – Design and reconstruct new TI (SPUI) Planned Capacity expansion planned entire segment listed in various planning documents All interchanges planned for upgrade

Table 16: Freight Deficiency Contributing Factors (Step 3)

Segment	Segment Mileposts (MP)	Segment Length (miles)	Refined Deficiency	Relevant Freight-Related Existing Infrastructure	Directional Truck Planning Time Index (TPTI)	Directional Truck Travel Time Index (TTTI)	Closure Extent					Programmed and Planned Projects	Contributing Factors to Refined Deficiency	Final Deficiency
							Total Number of Closures	% Closures (No Reason)	% Incidents/ Accidents	% Obstructions/ Hazards	% Weather Related			
19-1	0-3	3	High	- Mariposa Land Port of Entry in Nogales on SR 189 - MP 0.12 Variable Message Sign	see Contributing Factors	see Contributing Factors	6	0%	83%	0%	17%	No Freight related projects planned or programmed	Transition from surface street to controlled access freeway; average segment speeds fall significantly below posted speeds. Heavy truck traffic origin/destination via Mariposa TI and SR 189 contributes to congestion/delay in immediate vicinity of TI.	High
19-2	3-18	15	None	None	None	None	30	0%	97%	3%	0%	No Freight related projects planned or programmed	None	None
19-3	18-30	12	High	None	see Contributing Factors	see Contributing Factors	9	0%	78%	22%	0%	No Freight related projects planned or programmed	MP 25.00 NB Border Patrol Check Station at Tubac requires all traffic to stop for inspection, causing average speeds to fall significantly below posted speeds. This is considered a non-actionable item by ADOT therefore the level of deficiency is removed	None
19-4	30-40	9	None	None	None	None	12	8%	83%	8%	0%	No Freight related projects planned or programmed	None	None
19-5	40-57	18	None	None	None	None	42	0%	100%	0%	0%	No Freight related projects planned or programmed	None	None
19-6	57-64	7	None	- MP 58.10 Variable Message Sign	None	None	21	33%	67%	0%	0%	No Freight related projects planned or programmed	None	None

8 SEGMENT REVIEW (STEP 4)

As defined in Section 2.4, values of 0, 1, 2, and 3 were assigned to the final deficiency levels (from Step 3) of None, Low, Medium, and High, respectively. A weight of 1.5 is applied to the performance areas that were identified as Emphasis Areas for each corridor in Draft Working Paper 3 and a weighted average deficiency was calculated for each segment. The resulting deficiency value can be used to compare across corridors and to determine the location of the highest deficiencies on a given corridor at a segment level. During the Corridor Vision process for I-19, the Mobility, Freight, and Safety Performance Areas were identified as Emphasis Areas. A summary of the segment deficiencies is shown in **Table 17.** The results in Table 17 can be used to compare the level of deficiency across corridors. **Figure 6** shows the range of segment deficiencies for the I-19 corridor.
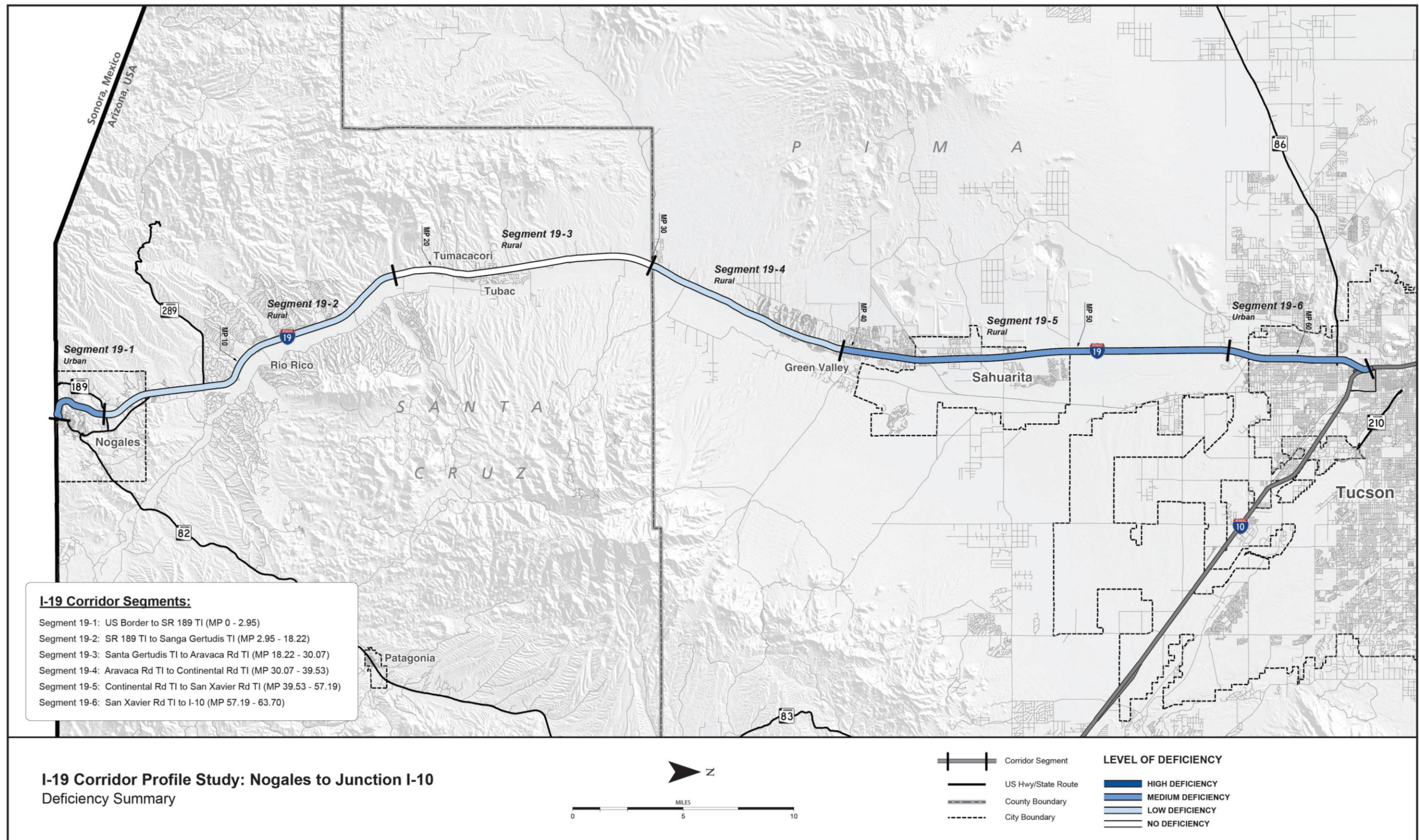
Table 17: Segment Deficiency Summary

Performance Area	Segment					
	19-1	19-2	19-3	19-4	19-5	19-6
Pavement	Low	Low	None	Low	None	Low
Bridge	Medium	Medium	None	None	Medium	Medium
Mobility*	None	None	None	None	None	High
Safety*	None	Low	None	Low	High	Medium
Freight*	High	None	None	None	None	None
Average (0-3)	1.2	0.7	0.0	0.4	1.0	1.6

*Indicates an Emphasis Area where a weight of 1.5 is applied to the deficiency level for each performance area.

Deficiency Category	Deficiency Score	Average Deficiency Range
None	0	< 0.0
Low	1	0.1 - 1.0
Medium	2	1.0 - 2.0
High	3	> 2.0

Figure 6: Deficiency Summary

I-19 Corridor Segments:

Segment 19-1: US Border to SR 189 TI (MP 0 - 2.95)

Segment 19-2: SR 189 TI to Sanga Gertudis TI (MP 2.95 - 18.22)

Segment 19-3: Santa Gertudis TI to Aravaca Rd TI (MP 18.22 - 30.07)

Segment 19-4: Aravaca Rd TI to Continental Rd TI (MP 30.07 - 39.53)

Segment 19-5: Continental Rd TI to San Xavier Rd TI (MP 39.53 - 57.19)

Segment 19-6: San Xavier Rd TI to I-10 (MP 57.19 - 63.70)

I-19 Corridor Profile Study: Nogales to Junction I-10

Deficiency Summary

MILES
0   5   10

	Corridor Segment
	US Hwy/State Route
	County Boundary
	City Boundary

LEVEL OF DEFICIENCY

- HIGH DEFICIENCY
- MEDIUM DEFICIENCY
- LOW DEFICIENCY
- NO DEFICIENCY

9 STEP 5: SUMMARY CORRIDOR NEEDS

This step summarizes the actionable needs on I-19 that will facilitate development of solution sets for preserving, modernizing, and expanding corridor investments. The deficiencies and contributing factors for each performance area were reviewed on a segment-by-segment basis to identify their needs. The process identifies overlapping, common, and contrasting needs to help develop strategic solutions.

Figure 7 illustrates corridor needs for each performance area as well as programmed projects that have not yet been constructed. Such programmed projects may address the identified need and will be taken into account when developing and prioritizing solutions in subsequent tasks of this Corridor Profile Study.

For additional detail on specific needs by location, refer to the information in Step 3 of each performance area, as noted in each section below.

Pavement Needs

In general, the I-19 corridor shows a relatively good level of pavement performance, with some portions of Segments 1, 2, 4, and 6 where a Low level of need is identified. For more information see **Figure 4** and **Table 4.**

Segment 1

- Low PSR, PDI and Composite scores occur at milepost 0-1 with a failure hotspot in the same area due to a high IRI and cracking rating.
- A pavement preservation project is programmed for FY 15 from milepost 0-3 which should mitigate these issues.

Segment 2

- High level of historic investment at milepost 6-9 where the AC and AR/ACFC has been repeatedly replaced and addressed over time. This area of the corridor may be a candidate for life cycle cost analysis and risk assessment to evaluate alternatives ranging from continuing routine maintenance to pavement reconstruction.
- Low PSR ratings including a failure hot spot due to cracking at milepost 17-18.

Segment 4

- Low PDI and Composite score occur at milepost 32-33.
- Low PSR and Composite score occur at milepost 35-40.
- A pavement rehabilitation project is programmed for FY 2019 at milepost 30-40 which should mitigate these issues.

Segment 6

- Low PSR and Composite score occur at milepost 60-64.
- Failure hot spots occur in both the northbound and southbound lanes at milepost 62-63.
- Medium level of recurring investment may indicate wear on the top course AC over PCCP.
- A mainline reconstruction project is programmed for FY 18 between milepost 58-62 which will not fully address the pavement needs identified. This section of the corridor may be a candidate for life cycle cost analysis and risk assessment to understand the benefits of expanding this programmed project to address the full need of the area.

Bridge Needs

A Medium level of need has been identified on Segments 1, 2, 5, and 6, with 22 bridges total over the length of the corridor needing improvements. Noted deficiencies include low ratings in substructure, deck, and superstructure elements, as well as a history of declining ratings over time on certain structures. There are three functionally obsolete and six structurally deficient bridges on the corridor. Of the bridges identified on the corridor, seven have ratings below 5 in multiple areas and six have ratings of 4 or lower. For more information see **Figure 5** and **Table 7.**

Segment 1

- 2 of 4 bridges have low superstructure ratings, including one that is listed as functionally obsolete.

Segment 2

- 7 bridges require improvements, 2 of which are listed as functionally obsolete.
- 4 of the 7 bridges listed as needing improvements have multiple issues including deck deterioration.

Segment 5

- 7 bridges require improvements, including 6 which are structurally deficient with deck ratings of 4.
- All bridges with a deck rating of 4 are programmed in ADOT's Five-Year Program.

Segment 6

- 5 bridges require improvements, with 1 structure programmed in the ADOT's Five-Year Program
- 2 bridges were recommended during recent inspections to be listed as high priority rehabilitation, but are not programmed for repair.

Mobility Needs

The Mobility Performance Area is an emphasis area for the I-19 corridor. A High level of need is identified in Segment 6 within the Tucson urban area, based on heavy northbound flows during peak hours. Congestion levels are consistent throughout the seven day week. Level of Service is projected to worsen over time, extending to hours outside the traditional peak unless capacity or operational improvements are implemented. For more information see **Table 10.**

- Crash-related lane closures contribute to congestion in Segment 6.
- The Ajo Way TI is programmed for reconstruction with the I-19 mainline being reconstructed between milepost 58-62.
- The Irvington Road TI is programmed for reconstruction with a Single Point Urban Interchange (SPUI) in FY 19.
- Through a DCR, the I-19 mainline between San Xavier Road and I-10 has been identified for expansion to four through-lanes in each direction but is not yet included as a programmed project.

Safety Needs

The Safety Performance Area is an emphasis area for the I-19 corridor. Four segments are identified with Safety needs. For more information see **Table 13.**

Segment 2

A Low level of need is identified due to higher levels of fatal and serious injury crashes, increasing volumes and spot congestion near Mariposa TI ramps. A Safety hot spot is identified in the northbound direction from MP 9-10. Accident types exceeding statewide averages include:

- Collisions with fixed object.
- Single vehicle crashes.
- Involving vehicles in transport.

Segment 4

A Low level of need is identified due to higher levels of fatal and serious injury crashes. Safety hot spots are identified in the northbound direction from mileposts 30-31, 33-34, and 39-40. Spot congestion near freeway ramps may be a contributing factor. Accident types exceeding statewide averages include:

- Dark unlighted conditions.
- Involving vehicles in transport.

Segment 5

A High level of need is identified due to higher levels of fatal and serious injury crashes. Contributing factors may include higher traffic volumes, urban operating conditions and weaving/entering/exiting problems for drivers.

The Tucson District has expressed concern about alcohol-related accidents near the casino in this area. Safety hot spots are identified in the northbound direction at mileposts 43-45; 53-56 and in the southbound direction from MP 47-49 and 54-55. Accident types exceeding statewide averages include:

- Collision with motor vehicle.
- Sideswipe.
- Rear end.
- Improper lane change.
- Involving vehicles in transport.
- Equipment failure.

Segment 6

A Medium level of need is identified due to higher levels of fatal and serious injury crashes. Contributing factors may include higher traffic volumes, urban operating conditions, congestion, and weaving/entering/ exiting problems for drivers. Safety hot spots are identified in the northbound direction at mileposts 58-63 and in the southbound direction from milepost 61-62. Accident types exceeding statewide averages include:

- Collision with pedestrian
- Collision with motor vehicle
- Rear end
- Occur in dark (lighted and unlighted)

- Involving vehicles in transport,
- Equipment failure

Freight Needs

The Freight Performance Area is an emphasis area for the I-19 corridor. Freight needs are identified on Segment 1 where the transition from Surface Street to controlled access freeway is difficult to navigate with sustained speeds, resulting in elapsed times less than allowed by posted speed limits. In addition, heavy truck traffic related to the international border crossing enters I-19 via the Mariposa TI and SR 189, contributing to congestion and delay in the segment. The area surrounding the Mariposa TI may be a candidate for life cycle cost analysis and risk assessment to help determine the value of improving operations for freight and overall mobility in this area. For more information see **Table 16.**

Overlapping Needs

This section identifies overlapping performance needs on I-19 which provides guidance to identify efficient solutions that address more than one problem. Completing projects that simultaneously address multiple needs may present the opportunity for cost savings as well as being most effective in improving overall measured system performance. The map in **Figure 7** shows the extent of overlapping needs.

Segment 1

Bridge and Freight needs in the Nogales urban area coincide on the area south of the intersection with SR 189. Significant levels of truck traffic contribute to delays, especially on the non-divided portion.

Segment 2

Safety, Bridge, and Pavement needs overlap on the segment north of Nogales. Multiple narrow bridges, poor pavement and truck traffic may be contributing factors to the safety issues. Solutions should examine ways to simultaneously address these problems in a more cost effective way.

Segment 4

Safety needs are identified for the full length of Segments 4, 5, and 6, overlapping with poor Pavement in between mileposts 32-40.
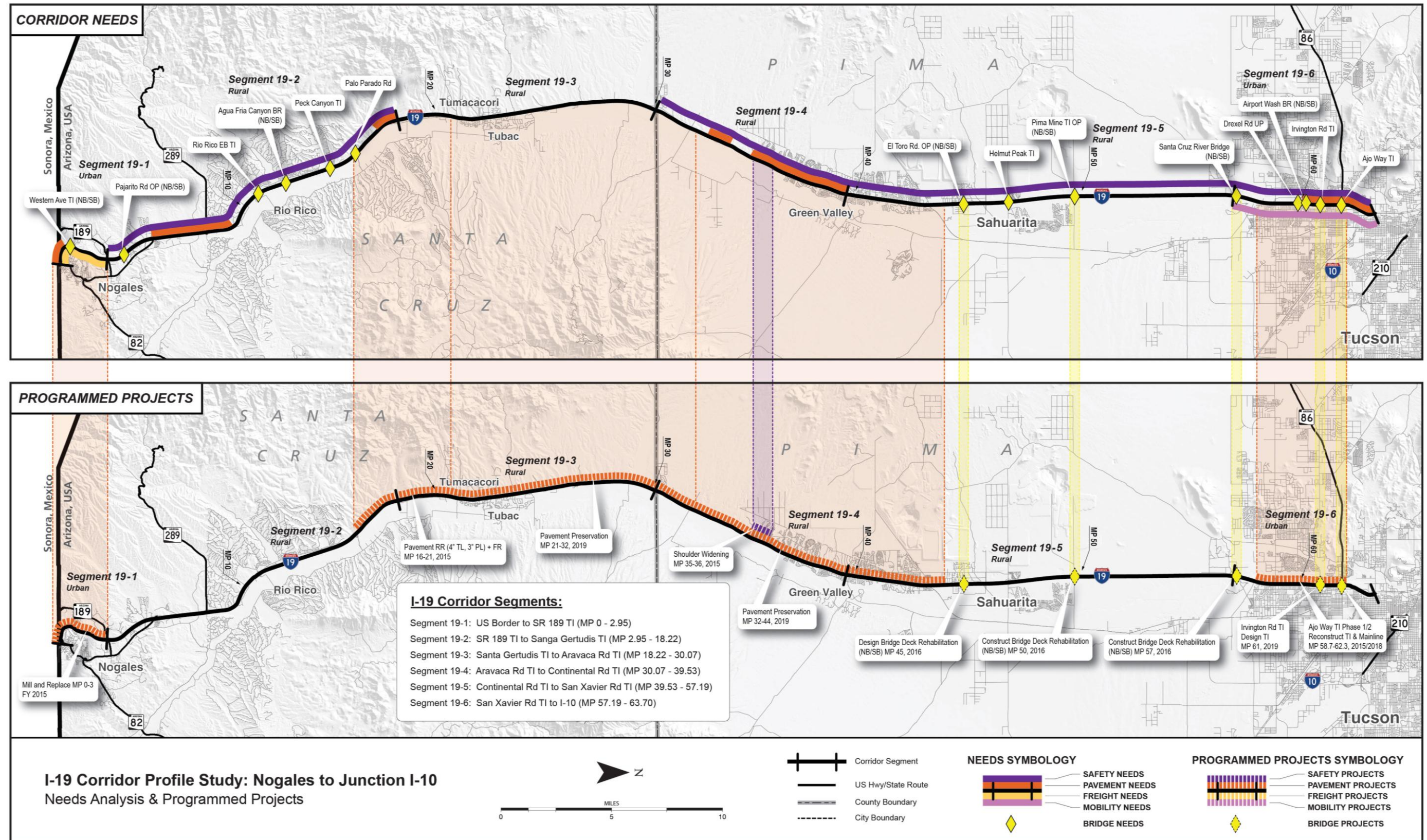
Segment 5

Safety and Bridge needs overlap in Segment 5, with multiple outdated traffic interchanges and structurally deficient bridges. A comprehensive program to address Safety deficiencies could be integrated with the programmed bridge replacements in this increasingly urbanized segment with projected declines in Level of Service over time.

Segment 6

Four performance areas (Safety – Pavement – Bridge – Mobility) show needs in Segment 6, the Tucson urban area. Planned capacity enhancement projects would simultaneously address many of these issues in the near term. Project development should deliberately identify ways to achieve results in all areas.

Figure 7: Summary Corridor Needs

CORRIDOR NEEDS

Segment 19-1 *Urban*
Western Ave TI (NB/SB)
Pajarito Rd OP (NB/SB)
Nogales

Segment 19-2 *Rural*
Rio Rico EB TI
Agua Fria Canyon BR (NB/SB)
Peck Canyon TI
Palo Parado Rd
Rio Rico

Segment 19-3 *Rural*
Tumacacori
Tubac

Segment 19-4 *Rural*
Green Valley

El Toro Rd. OP (NB/SB)
Helmut Peak TI
Pima Mine TI OP (NB/SB)

Segment 19-5 *Rural*
Sahuarita
Santa Cruz River Bridge (NB/SB)

Segment 19-6 *Urban*
Airport Wash BR (NB/SB)
Drexel Rd UP
Irvington Rd TI
Ajo Way TI

SANTA CRUZ
PIMA
Tucson

PROGRAMMED PROJECTS

Segment 19-1 *Urban*
Mill and Replace MP 0-3 FY 2015
Nogales

Segment 19-2 *Rural*
Pavement RR (4" TL, 3" PL) + FR MP 16-21, 2015
Rio Rico

Segment 19-3 *Rural*
Pavement Preservation MP 21-32, 2019
Tumacacori
Tubac

Shoulder Widening MP 35-36, 2015
Pavement Preservation MP 32-44, 2019

Segment 19-4 *Rural*
Green Valley

Design Bridge Deck Rehabilitation (NB/SB) MP 45, 2016

Segment 19-5 *Rural*
Sahuarita
Construct Bridge Deck Rehabilitation (NB/SB) MP 50, 2016
Construct Bridge Deck Rehabilitation (NB/SB) MP 57, 2016

Segment 19-6 *Urban*
Irvington Rd TI Design TI MP 61, 2019
Ajo Way TI Phase 1/2 Reconstruct TI & Mainline MP 58.7-62.3, 2015/2018
Tucson

SANTA CRUZ
PIMA

I-19 Corridor Segments:

Segment 19-1: US Border to SR 189 TI (MP 0 - 2.95)
Segment 19-2: SR 189 TI to Sanga Gertudis TI (MP 2.95 - 18.22)
Segment 19-3: Santa Gertudis TI to Aravaca Rd TI (MP 18.22 - 30.07)
Segment 19-4: Aravaca Rd TI to Continental Rd TI (MP 30.07 - 39.53)
Segment 19-5: Continental Rd TI to San Xavier Rd TI (MP 39.53 - 57.19)
Segment 19-6: San Xavier Rd TI to I-10 (MP 57.19 - 63.70)

I-19 Corridor Profile Study: Nogales to Junction I-10
Needs Analysis & Programmed Projects

MILES
0   5   10

Corridor Segment
US Hwy/State Route
County Boundary
City Boundary

NEEDS SYMBOLOGY
SAFETY NEEDS
PAVEMENT NEEDS
FREIGHT NEEDS
MOBILITY NEEDS
BRIDGE NEEDS

PROGRAMMED PROJECTS SYMBOLOGY
SAFETY PROJECTS
PAVEMENT PROJECTS
FREIGHT PROJECTS
MOBILITY PROJECTS
BRIDGE PROJECTS

10 NEXT STEPS IN CORRIDOR PROFILE STUDY

The principal objective of the corridor profile study is to identify performance-based strategic solutions (investments) to ensure that available funds result in maximizing the performance of the State's most strategic transportation corridors.

Actionable performance needs documented in Working Paper 4 will serve as a foundation for developing strategic investments for corridor preservation, modernization, and expansion. Strategic investments are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and consultants develop candidate projects for consideration in performance-based programming in the P2P Link process. Rather, strategic investments are intended to complement ADOT's traditional project development processes with non-traditional projects to address performance needs in one or a combination of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic investments developed for strategic corridors will be considered along with other candidate projects in the ADOT programming process.

Investment strategies will be developed in Tasks 5-7 of the Corridor Profile Study process. The process includes collaboration with the Technical Advisory Committee and ADOT groups to identify strategic solutions to address corridor needs and to evaluate these alternatives through a systematic analysis of life cycle costs and risks.

The strategic solutions identified in this study will focus on projects that maximize the use of funds to achieve corridor goals and objectives.

Illustrative examples of strategic investments include:

- *Projects that address significant performance needs.* Projects that address a Medium or High performance need identified in the corridor profile study that have a high probability to significantly improve corridor performance may be identified as strategic investments. These projects may include a project in the current program, a planned project not in the current program, or a new project recommended in the corridor profile study.

- *Combining projects to address needs in multiple performance areas.* For example, a single project to rehabilitate the pavement surface and multiple bridge decks on a segment of roadway would address multiple performance areas (Pavement and Bridge) and could result in significant cost savings in traffic control (as compared to traffic control costs for separate projects to rehabilitate pavement surface and bridge decks). Another example would be that a travel lane pavement rehabilitation project could be expanded to include shoulder rehabilitation and rumble strip construction to reduce road departure safety needs.

- *Projects that address repetitive issues.* For example, if there is a history of high levels of maintenance activities at a particular bridge or segment of pavement, there may be an underlying need that if addressed properly will reduce the need for future maintenance. Higher-cost strategic capital investments to correct repetitive maintenance issues can result in life cycle cost savings by reducing maintenance costs over time.

- *Phased projects to achieve a long-term improvement objective.* For example, a life cycle cost analysis may recommend total pavement reconstruction to address a subgrade failure; however the cost of reconstruction is not feasible from a funding perspective. A strategic

investment may be recommended to extend the life of the current pavement infrastructure until funding availability allows for full pavement reconstruction.

- *Risk Analysis.* Solutions that lower ADOT's financial and other Departmental risks. For example, identifying projects that are most likely to receive funding over the near to medium term, may reduce risks to a greater extent than major, costly projects that are unlikely to receive sufficient funds for full implementation in a reasonable time frame.

- *Modernization Projects.* This corridor profile study will focus on solutions that extend the operational life of the corridor without adding capacity, where possible. Examples could include electronic communication systems that help travelers avoid congestion or truck climbing lanes that enhance flow in shorter congested areas or with low scores in the Travel Time Index or Planning Time Index.

Figure 8 identifies the remaining tasks for this Corridor Profile Study.

Figure 8: Corridor Profile Study Tasks
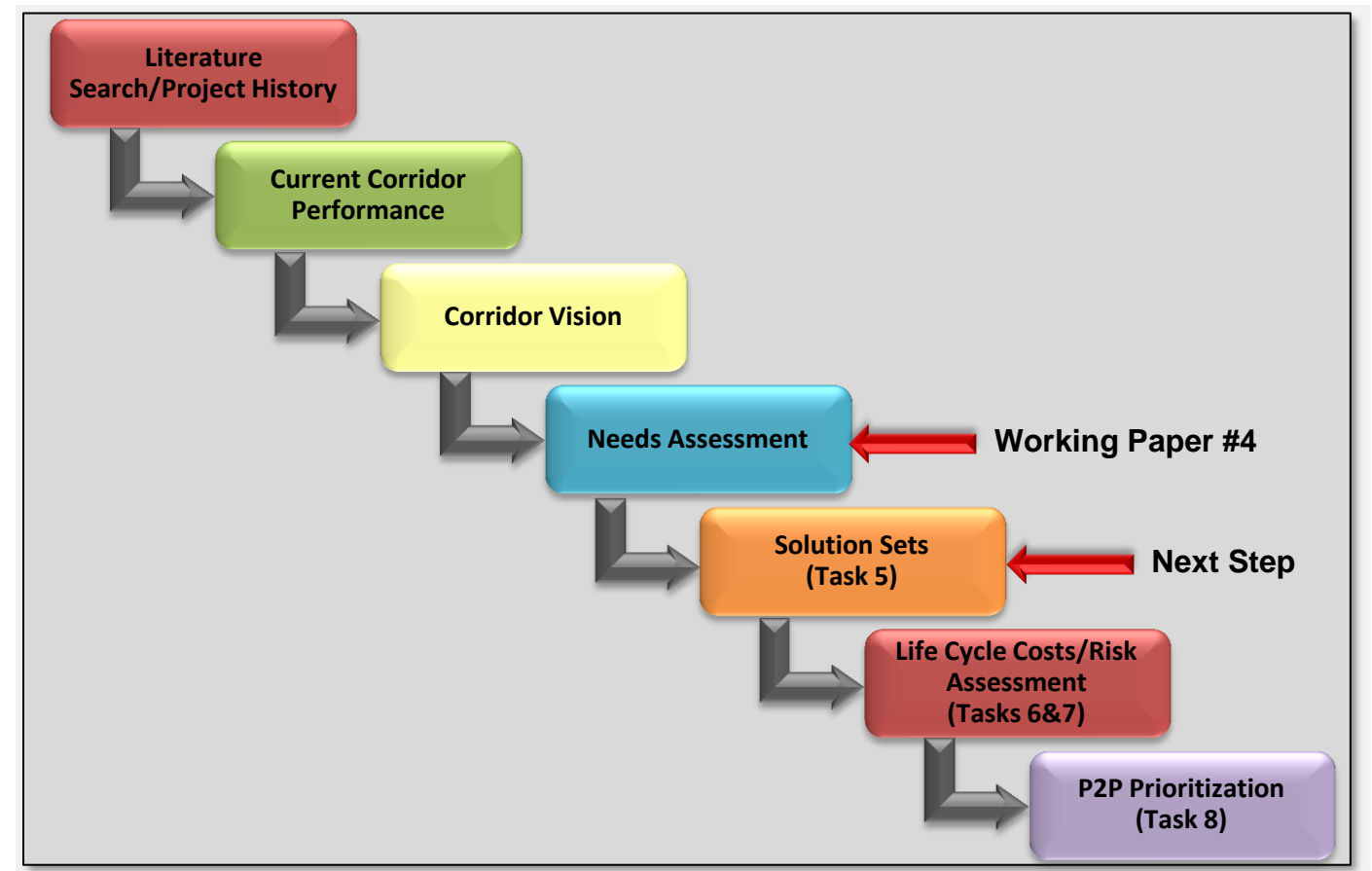
APPENDIX A:

Methodologies for Determining Performance Area Deficiencies (Steps 1-3)

Pavement Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Pavement Performance Area. The 5-step process is listed below:

- Step 1: Initial Deficiencies
- Step 2: Refined Deficiencies
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Deficiencies

The Step 1 sample template is illustrated in **Table 1** for the I-19 corridor.

The input required to populate the Step 1 template includes transferring the existing performance score and color for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Pavement. As each performance score is input into the template, the Initial Deficiency (Column O) will populate based on the weighted scoring system for each measure.

The Level of Deficiency for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" within the Step 1 template (Table 1).

To develop an aggregated Initial Deficiency for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Deficiency for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score ≥ 0.01 and < 1.5), "Medium" (score ≥ 1.5 and < 2.5), and "High" (score ≥ 2.5).

The steps include:

Step 1.1

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Task 2/WP#2 into Columns D, G, H, and L. Copy the performance score and color for each segment to the appropriate "Performance Score" column.

Step 1.2

Confirm that that the Step 1 template is generating the appropriate "Level of Deficiency" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of deficiency.

Step 2: Refined Deficiencies

The Initial Deficiency will be carried over to Step 2 (Column E). The Step 2 sample template is illustrated in **Table 2** for the I-19 corridor.

The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial deficiencies from the Step 1 template to Column E of the Step 2 template.

Step 2.2

Note in Column F any pavement failure hot spots identified as part of the baseline corridor performance. For each entry, note the milepost of the hot spot. Hot spots are identified by the red circles in Columns F, G, I, and J.

Step 2.3

Identify the historical level of investment in Column H as either "Low", "Medium", or "High" based on the following criteria:

- < 4.60 = "Low"
- 4.60 - 6.60 = "Medium"
- > 6.60 = "High"

See the enclosed instructions for quantifying the historical level of investment.

Step 2.4

Identify recently completed or under construction paving projects in Column H. Include only projects that were completed after the pavement condition data period (check dates in pavement condition data provided by ADOT)(generally 2012-2013) that would supersede the results of the performance system.

Step 2.5

Update the Refined Deficiency (Column I) using the following criteria:

- If "None" but have hot spots or "High" historical investment, the Refined Deficiency = Low, and note the reason for the change in Column J.
- If "Low" but have High historical investment, the Refined Deficiency = Medium, and note the reason for the change in Column J.
- If "Medium" but have High historical investment, the Refined Deficiency = High, and note the reason for the change in Column J.
- If a recent project (Column H) has superseded the performance rating data, change the deficiency rating to "None" and note the reason for the change in Column J.

Table 1 - Step 1 Template

Pavement

Segment	Segment Mileposts	Segment Length (miles)	Pavement Index			Directional PSR						% Pavement Failure			Initial Deficiency
			Performance Score	Performance Objective	Level of Deficiency	Performance Score		Performance Objective	Level of Deficiency			Performance Score	Performance Objective	Level of Deficiency	
						NB	SB		NB	SB					
19-1	0-3	3	4.03	Fair or Better	None	3.72	3.96	Fair or Better	None	None		16.67%	Fair or Better	Medium	Low
19-2	3-18	15	4.39	Fair or Better	None	4.28	4.26	Fair or Better	None	None		3.33%	Fair or Better	None	None
19-3	18-30	12	3.57	Fair or Better	None	3.74	3.90	Fair or Better	None	None		0.00%	Fair or Better	None	None
19-4	30-40	9	3.54	Fair or Better	Low	3.76	3.90	Fair or Better	None	None		0.00%	Fair or Better	None	Low
19-5	40-57	18	4.08	Fair or Better	None	3.97	4.02	Fair or Better	None	None		0.00%	Fair or Better	None	None
19-6	57-64	7	3.61	Fair or Better	None	3.54	3.57	Fair or Better	Low	None		18.75%	Fair or Better	Medium	Low
Weighted Average			3.93	Fair or Better	None										

Scale

Measure	None >=	Low >=	> Medium <		High <=
Pavement Index	3.57	3.38	3.38	3.02	3.02
Directional PSR	3.57	3.38	3.38	3.02	3.02
%Pavement Failure	10%	15%	15%	25%	25%

Example Scales for Level of Deficiency

Performance Thresholds	Level of Deficiency	Description
5%	None	
	Low	Middle 1/3rd of Fair Performance
20%	Medium	Lower 1/3rd of Fair and top 1/3rd of Poor Performance
	High	Lower 2/3rd of Poor Performance

Table 2 - Step 2 Template

Segment	Segment Mileposts (MP)	Segment Length (miles)	Initial Deficiency	Deficiency Adjustments			Refined Deficiency	Comments (may include programmed projects or issues from previous reports)
				Hot Spots	Historical Investment	Previous Projects (supersede condition data - 2013)		
19-1	0-3	3	Low	NB MP 0.00-1.00	Medium	Pavement preservation from MP 0 - MP 6 including milling and replacement of asphalt-rubber course and pavement markings	None	Failure hot spot NB (MP 0-1); Medium level of historical investment; Level of deficiency has been lowerd based on project being under construction
19-2	3-18	15	None	NB MP 17.00-18.24	High		Low	Failure hot spot NB (MP 17-18); High level of historical investment; Pavement Preservation (RR[4" TL, 3" PL] + FR) from MP 16 - MP 21 is programmed in FY 15
19-3	18-30	12	None	None	Low		None	
19-4	30-40	9	Low	None	Medium		Low	Medium level of previous investment; Pavement Preservation MP 30 - MP 40 is programmed in FY 19
19-5	40-57	18	None	None	Medium		None	
19-6	57-64	7	Low	NB & SB MP 62.00-63.00 SB MP 63.00-63.69	Medium		Low	Failure hot spot NB and SB (MP 62-63); Medium level of historical investment; No future projects currently programmed
						*Request ADOT for data on projects that have been constructed that would supersede condition data		*Previous reports should be reviewed to determine if issues noted in Step 2 have previously been identified

Instructions:

1. Enter segment information in Columns A-C

2. Input values for Deficiency Summary (Column D) from the Step 1 Pavement Performance Area Deficiency Summary Table

3. Input Hot Spots (Column E) by segment identified during the Performance Assessment

4. Input Historical Investment information (Column F) based on the Pavement History Tables

      0 - 4.60 = "Low"

      4.60 - 6.60 = "Medium"

      > 6.60 = "High"

5. Identify previous projects (projects that were completed after the last pavement rating and are not reflected in the Pavement Condition data) under each segment (Column G)

6. Update Resulting Deficiency (Column H) using the following thresholds:

      If "None" but have hot spots or High historical investment = Low

      If "Low" but have High historical investment = Medium

      If "Medium" but have High historical investment = High

      If a recent project (column G) has superseded the rating data, resulting deficiency (Column H) should be reduced to account for the project. The change and reason for the change should be noted in Column I.

7. Identify any programmed projects, issues identified by previous projects, or any relevant comments related to the segment under Column H

      Only provide information related to deficiencies identified through this process; do not provide additional information that would identify additional deficiencies

Step 2.6

Note any programmed projects that could have the potential to mitigate pavement deficiencies in Column J. Programmed projects are provided as information and do not impact the deficiency rating. The program information can be found in ADOT's 5-year construction program. If there are other comments relevant to the needs analysis (such as information from previous reports), they can be entered in the right-most column (Column J). However, only include information related to deficiencies that have been identified through this process. Do not add or create deficiencies from other sources.

Step 3: Contributing Factors

The Refined Deficiency ratings from Step 2 will populate into the Step 3 tab (Column D). The Step 3 sample template is illustrated in **Table 3** for the I-19 corridor.

The steps to compete Step 3 include:

Step 3.1

Input milepost ranges of the pavement deficiencies into Column E by reviewing the Pavement Performance calculation worksheet from Task 2/WP#2 and identify areas of PSR (Columns K & M) or Composite score (Columns O and P) that are less than approximately 3.55.

Step 3.2

Note the milepost ranges of pavement failure into Column E (hot spots from Step 2).

Step 3.3

Note any other information that may be contributing to the deficiency, or supplemental information, in Column E. This could come from discussions with ADOT District staff, ADOT Materials/Pavement Group, previous reports, or the historical investment data.

Step 3.4

Input any programmed projects from ADOT's 5-year construction program into Column E.

Step 3.5

After reviewing all of the information provided in Step 3, determine a Final Deficiency level for each segment. This deficiency level would only deviate from the Refined Deficiency if the analysis of Step 3 identified a previously unknown pavement performance issue (which would increase the deficiency level), or identified that there are no observable pavement performance issues (which would decrease the deficiency level). For the Pavement Performance Area, it is highly unlikely that the Final Deficiency would deviate from the Refined Deficiency.

Table 3 - Step 3 Template

Segment	Segment Mileposts (MP)	Segment Length (miles)	Refined Deficiency	Contributing Factors and Comments	Final Deficiency
19-1	0-3	3	None	Failure hot spot NB (MP 0-1); Medium level of historical investment; Project under construction will mitigate issues	None
19-2	3-18	15	Low	Failure hot spot NB (MP 17-18); High level of historical investment; Project is programmed in FY 15 should mitigate issues	Low
19-3	18-30	12	None		None
19-4	30-40	9	Low	Medium level of previous investment; Project is programmed in FY 19 should mitigate issues	Low
19-5	40-57	18	None		None
19-6	57-64	7	Low	Failure hot spot NB and SB (MP 62-63); Medium level of historical investment; No future projects currently programmed	Low
				- Communicate with ADOT District(s) to obtain input to contributing factors	

Bridge Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Bridge Performance Area. The 5-step process is listed below:

- Step 1: Initial Deficiencies
- Step 2: Refined Deficiencies
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Deficiencies

The Step 1 sample template is illustrated in **Table 1** for the I-19 corridor.

The input required to populate the Step 1 template includes transferring the existing performance score and color for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Bridge. As each performance score is input into the template, the Initial Deficiency (Column Q) will populate based on the weighted scoring system for each measure.

The Level of Deficiency for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" within the Step 1 template (Table 1).

To develop an aggregated Initial Deficiency for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Deficiency for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5).

The steps include:

Step 1.1

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Task 2/WP#2 into Columns E, H, K, and N. Copy the performance score and color for each segment to the appropriate "Performance Score" column.

Step 1.2

Confirm that that the Step 1 template is generating the appropriate "Level of Deficiency" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of deficiency.

Step 2: Refined Deficiencies

The Initial Deficiency will be carried over to Step 2 (Column E). The Step 2 sample template is illustrated in **Table 2** for the I-19 corridor.

The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial deficiencies from the Step 1 template to Column E of the Step 2 template.

Step 2.2

Note in Column F any bridge hot spots identified as part of the baseline corridor performance. For each entry, note the number of bridges and the location. Hot spots are identified as having any bridge rating of 4 or less.

Step 2.3

Bridge rating data for the time period from 1997 to 2014 was tabulated and graphed to find any bridges that had fluctuations in the ratings. Note in Column G any bridge that was identified as having a potential historical rating concern based on the following criteria:

- Ratings increase or decrease (bar chart) more than 2 times
- Sufficiency rating drops more than 20 points

Step 2.4

Note the number of functionally obsolete bridges in each segment in Column H.

Step 2.5

Identify recently completed or under construction bridge projects in Column I. Include only projects that were completed after the bridge condition data period (check dates in bridge condition data provided by ADOT) (generally 2012-2014) that would supersede the results of the performance system.

Step 2.6

Determine the number of bridges "of concern" on each segment based on the following criteria:

- Any bridge with any rating of 5 or less
- Any bridge identified through the historical rating review (step 2.3 above)

Enter the number of bridges "of concern" in Column M and verify that Column N lists the total number of bridges on each segment. Update the Refined Deficiency (Column J) using the following criteria:

- 0% = None
- 0%-34% = Low
- 35% - 60% = Medium
- > 60% = High
- These thresholds were established for segments with approximately 10 bridges. If a segment has only 2 bridges and 1 is "of concern" (50% of bridges), this segment should not be classified as "Medium" but

should be "Low". Similarly, if a segment has 25 bridges and 8 are "of concern" (32% of bridges), this segment should not be classified as "Low" but should be "High".

- For each segment with a Structurally Deficient Bridge (rating of 4 or less), increase the Deficiency by one level
- Functionally Obsolete Bridges should not contribute to the level of Deficiency
- If a recent project (Column H) has superseded the performance rating data, change the deficiency rating to "None"
- Note the reason for any change in Column K.

Step 2.7

Identify each bridge "of concern" in Column K. Note any programmed projects that could have the potential to mitigate bridge deficiencies in Column K. Programmed projects are provided as information and do not impact the deficiency rating. The program information can be found in ADOT's 5-year construction program. If there are other comments relevant to the needs analysis (such as information from previous reports), they can be entered in the right-most column (Column K). However, only include information related to deficiencies that have been identified through this process. Do not add or create deficiencies from other sources.

Table 1 - Step 1 Template

Segment	Segment Mileposts	Segment Length (miles)	Number of Bridges per Segment	Bridge Index			Bridge Rating			Bridge Sufficiency			% Functionally Obsolete Bridges			Initial Deficiency
				Performance Score	Performance Objective	Level of Deficiency	Performacne Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	
19-1	0-3	3	4	5.98	Fair or Better	Low	5	Fair or Better	Medium	90.03	Fair or Better	None	100.00%	Fair or Better	High	Medium
19-2	3-18	15	18	5.97	Fair or Better	Low	5	Fair or Better	Medium	89.70	Fair or Better	None	23.29%	Fair or Better	None	Low
19-3	18-30	12	9	6.18	Fair or Better	None	6	Fair or Better	None	93.08	Fair or Better	None	19.73%	Fair or Better	None	None
19-4	30-40	9	10	6.60	Fair or Better	None	6	Fair or Better	None	95.35	Fair or Better	None	15.72%	Fair or Better	None	None
19-5	40-57	18	21	5.30	Fair or Better	Medium	4	Fair or Better	High	90.92	Fair or Better	None	21.33%	Fair or Better	None	High
19-6	57-64	7	11	6.10	Fair or Better	None	5	Fair or Better	Medium	77.74	Fair or Better	None	18.84%	Fair or Better	None	Low
Weighted Average				5.91	Fair or Better	Low										

Scale					
Measure	None >=	Low >=	> Medium <		High <=
Bridge Index	6	5.5	5.5	4.5	4.5
Bridge Sufficiency	70	60	60	40	40
%Functionally Obsolete Bridges	25%	35%	35%	55%	55%

Example Scales for Level of Deficiency

Performance Thresholds	Level of Deficiency	Description
6.5	None	
	Low	Middle 1/3rd of Fair Performance
5	Medium	Lower 1/3rd of Fair and top 1/3rd of Poor Performance
	High	Lower 2/3rd of Poor Performance

NOTE: The value of the 1/3 sections was defined by the range of the "fair" rating. In this example, each 1/3 section has a value of 0.18. [(3.75-3.2)/3=0.18].

Table 2 - Step 2 Template

Segment	Segment Mileposts (MP)	Segment Length (miles)	Number of Bridges in Segment	Initial Deficiency	Deficiency Adjustments				Refined Deficiency	Comments (may include programmed projects or issues from previous reports)
					Hot Spots (Rating of 4)	Historical Review	# Functionally Obsolete Bridges	Previous Projects (which supersede condition data)		
19-1	0-3	3	4	Medium	-	1 Western Ave TI OP NB	4	No recent projects	Medium	Western Ave TI OP SB has also been identified for review due to low current performance ratings. No bridge listed for review have been identified for a future project.
19-2	3-18	15	18	Low	-	7 Pajarito Rd OP NB Pajarito Rd OP SB Ruby Road TI UP Agua Fria Cyn Br SB Peck Canyon TI UP Peck Cyn Wash BR SB Palo Parado TI UP	3	No recent projects	Medium	Rio Rico EB TI UP and Agua Fria Cyn Br NB have also been identified for review due to low current performance ratings. Of the identified bridges (Historical Review or Low Performance), the Rio Rico Drive TI, Peck Canyon TI, Peck Canyon Wash Bridge, and the Palo Parado TI were listed for improvements in the Unified Nogales Santa Cruz County Transporation Plan. The refined deficiency of this segment has been increased to Medium from Low based on 50% of the bridges being identified for review.
19-3	18-30	12	9	None	-	1 Agua Linda UP	0	No recent projects	Low	No project have been identifed for any future projects in this segment
19-4	30-40	9	10	None	-	-	2	No recent projects	None	No bridges with current ratings less than 6 and no historical issues with ratings
19-5	40-57	18	21	High	6 El Toro Rd OP NB El Toro Rd OP SB Pima Mine TI OP NB Pima Mine TI OP SB Santa Cruz Riv Br NB Santa Cruz Riv Br SB	8 El Toro Rd OP NB El Toro Rd OP SB Pima Mine TI OP NB Pima Mine TI OP SB Papago Res TI OP NB Papago Res TI OP SB Santa Cruz Riv Br NB Santa Cruz Riv Br SB	8	No recent projects	High	Helmut Peak TI UP has also been identified for review due to low current performance ratings. Of the bridges identified, El Toro Rd OP SB & NB Bridge Deck Rehabilitation has been programmed in the ADOT 5 year program in FY 16; Helmet Road TI has been identified for reconstruction in the PAG SE Area Study and the PAG 2040 Regional Transportation Plan; Pima Mine TI SB & NB has been programmed in the ADOT 5 year program in FY 16; Papago Res TI SB & NB has been identified for reconstruction in the I-19 Corridor Study (I-10 to Pima/Santa Cruz Line); Santa Cruz River Bridge SB & NB has been identified for Bridge Deck Rehabilitation in the ADOT 5 year program in FY 16.
19-6	57-64	7	11	Low	-	4 Valencia Road TI UP Drexel Road UP Airport Wash Br NB Airport Wash Br SB	2	No recent projects	Medium	Irvington Rd TI UP and Ajo Way UP have also been identified for review due to low current performance ratings. Of the bridges identified, Drexel Rd UP and the Irvington Rd TI have been listed for reconstruction in the I-19 San Xavier Road to I-10 Final DCR (2012); the Ajo Way TI has been identified for reconstruction in the ADOT 5 year program for FY 18. The refined deficiency of this segment has been increased to Medium from Low based on over 50% of the bridges being identified for review.

Step 3: Contributing Factors

For each bridge that was identified as part of the historical review (step 2.3), collect bridge inspection reports from ADOT Bridge Group to help determine if the bridge has had repetitive investments to mitigate the same issue (or very similar issues).

The Refined Deficiency ratings from Step 2 will populate into the Step 3 tab (Column E). The Step 3 sample template is illustrated in **Table 3** for the I-19 corridor.

The steps to compete Step 3 include:

Step 3.1

Input the bridge name, structure number, and milepost into Column F for each bridge "of concern" resulting from Step 2.

Step 3.2

For bridges that have a current rating of 5 or less, enter the specific rating in Column G, or state "No current ratings less than 6".

Step 3.3

For bridges that were identified for a historical review (step 2.3), note any findings in Column H. If a bridge was not identified for a historical review, state "This structure was not identified for a historical review".

Step 3.4

Input any programmed projects from ADOT's 5-year construction program into Column I. Note any other information that may be contributing to the deficiency, or supplemental information, in Column I. This could come from discussions with ADOT District staff, ADOT Bridge Group, or previous reports.

Step 3.5

After reviewing all of the information provided in Step 3, determine a Final Deficiency level for each segment. This deficiency level would only deviate from the Refined Deficiency if the analysis of Step 3 identified a previously unknown bridge performance issue (which would increase the deficiency level), or identified that there are no observable bridge performance issues (which would decrease the deficiency level). If any bridges are added or removed from a segment, update the data used in step 2.6.

Table 3 - Step 3 Template

Segment	Segment Mileposts (MP)	Segment Length (Miles)	Number of Bridges in Segment	Refined Deficiency	Bridges of Concern / Contributing Factors		
					Bridge	Current (2014) Ratings	Historical Review
19-1	0-3	3	4	Medium	**Western Ave TI OP NB (#1545) (MP 1.17)**	Current Superstructure Rating of 5	This structure is identified as functionally obsolete. It has experienced a shift in substructure and superstructure rating since 2007 due to spalling and abutment cracking. The presence of cracking in the T beams fascia extend between support abutments and were recommended for repair. No projects listed to improve this structure.
					Western Ave TI OP SB (#1546) (MP 1.17)	Current Superstructure Rating of 5	This structure was not identified for historical review.

Mobility Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Mobility Performance Area. The 5-step process is listed below. After completion of Step 3 for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to quantify a total level of deficiency that combines all performance areas. Corridor deficiencies are then translated to needs in Step 5 of the process in order to identify needs by type and overlapping needs throughout the corridor.

- Step 1: Initial Deficiencies
- Step 2: Refined Deficiencies
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

Step 1: Initial Deficiencies

The input required to populate the Step 1 template includes transferring the existing performance score and color for each segment to the appropriate "Performance Score" columns from Task 2/Working Paper #2. This includes the primary and secondary measures for Mobility. As each performance score is input into the template, the Initial Deficiency (Column N) will populate based on the weighted scoring system for each measure.

The Level of Deficiency for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" in columns W – AJ of the Step 1 Tab.

To develop an aggregated Initial Deficiency for each segment, the primary and secondary measures are combined by summing the weighted scores, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Deficiency for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5).

The steps include:

Step 1.1

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Task 2/Working Paper #2. Copy the performance score and color for each segment to the appropriate "Performance Score" column.

Step 1.2

Confirm that that the Step 1 template is generating the appropriate "Level of Deficiency" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of deficiency.

The step 1 template and scales for the mobility index are illustrated below for the I-19 corridor.

Step 1 Template - Mobility

Mobility

Segment	Segment Mileposts	Segment Length (miles)	Mobility Index			Future Daily V/C			Existing Peak Hour V/C					Closure Extent (occurrences/year/mile)				
			Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	Performance Score		Performance Objective	Level of Deficiency		Performance Score		Performance Objective	Level of Deficiency	
									NB	SB		NB	SB	NB	SB		NB	SB
19-1	0-3	3	0.23	Fair or Better	None	0.28	Fair or Better	None	0.17	0.17	Fair or Better	None	None	0.27	0.27	Fair or Better	None	None
19-2	3-18	15	0.46	Fair or Better	None	0.56	Fair or Better	None	0.28	0.30	Fair or Better	None	None	0.30	0.20	Fair or Better	None	None
19-3	18-30	12	0.37	Fair or Better	None	0.45	Fair or Better	None	0.21	0.23	Fair or Better	None	None	0.11	0.19	Fair or Better	None	None
19-4	30-40	9	0.40	Fair or Better	None	0.48	Fair or Better	None	0.27	0.28	Fair or Better	None	None	0.25	0.20	Fair or Better	None	None
19-5	40-57	18	0.66	Fair or Better	None	0.77	Fair or Better	None	0.51	0.48	Fair or Better	None	None	0.29	0.23	Fair or Better	None	None
19-6	57-64	7	1.04	Fair or Better	High	1.25	Fair or Better	High	0.90	0.76	Fair or Better	Medium	None	0.31	0.34	Fair or Better	None	None
	Weighted Average		0.54	Good	None													

Segment	Segment Mileposts	Segment Length (miles)	Directional TTI (all vehicles)					Directional PTI (all vehicles)					Initial Deficiency
			Performance Score		Performance Objective	Level of Deficiency		Performance Score		Performance Objective	Level of Deficiency		
			NB	SB		NB	SB	NB	SB		NB	SB	
19-1	0-3	3	1.40	1.01	Fair or Better	High	None	2.28	1.30	Fair or Better	High	None	Low
19-2	3-18	15	1.16	1.13	Fair or Better	None	None	1.25	1.22	Fair or Better	None	None	None
19-3	18-30	12	1.58	1.10	Fair or Better	High	None	2.50	1.17	Fair or Better	High	None	Low
19-4	30-40	9	1.06	1.06	Fair or Better	None	None	1.08	1.12	Fair or Better	None	None	None
19-5	40-57	18	1.06	1.08	Fair or Better	None	None	1.11	1.15	Fair or Better	None	None	None
19-6	57-64	7	1.00	1.04	Fair or Better	None	None	1.03	1.14	Fair or Better	None	None	High

Step 1 Template – Mobility Scale

Scale

Measure		None >=	Low >=	> Medium <		High <=
Mobility Index (Corridor)		0.58	0.71	0.71	0.83	0.83
Mobility Index (Segment)	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Future Daily V/C	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Existing Peak hour V/C	Urban	0.77	0.83	0.83	0.95	0.95
	Rural	0.63	0.69	0.69	0.83	0.83
Closure Extent		0.68	1.11	1.11	1.95	1.95
Directional TTI		1.21	1.27	1.27	1.39	1.39
Directional PTI		1.37	1.43	1.43	1.57	1.57
% Non-SOV Trips		15%	13%	13%	9%	9%

Step 2: Refined Deficiencies

The Initial Deficiency will be carried over to Step 2 (Column D). The Step 2 sample template is illustrated in **Table 2** for the I-19 corridor.

Table 18 - Step 2 Example

I-19: Step 2 - Mobility

Segment	Segment Mileposts (MP)	Segment Length (miles)	Initial Deficiency	% of Weekend Traffic (Fri-Sun) Volumes Resulting in Poor Mobility Index	Recent Projects Since 2013	Refined Deficiency	Planned and Programmed Future Projects
19-1	0-3	3	Low	No Data	None	Low	Planned I-19, I-19B Terminus to West Street - Roadway Improvements for Future Capacity I-19 and Mariposa TI reconfiguration
19-2	3-18	15	None	No Data	None	None	Planned I-19, SR 189/Mariposa Road TI to Tumacocori TI – Roadway Improvements for Future Capacity I-19, Exit 22 (Peck Canyon Rd) to Exit 48 (Arivaca Road) – Interchange Improvements
19-3	18-30	12	Low	0%	None	Low	Programmed (FY 2015) Canoa Shooulders - Construct Shoulder Widening
19-4	30-40	9	None	No Data	None	None	Nothing planned or programmed in this segment
19-5	40-57	18	None	No Data	None	None	Programmed (FY2015) Reconstruct the existing ramps in the southbound direction between I-10 and Ajo Way (SR 86), and between Ajo Way and Irvington Road as braided ramps (Phase 1) (FY 2018) Reconstruct the existing partial clover leaf TI at Ajo Way (SR 86) to a SPUI (Phase 2) Planned Esperanza, Duval Mine Rd, Helmet Peak, Pima Mine Rd, Papago TI reconstruction projects listed in various planning documents Capacity expansion planned entire segment listed in various planning documents (2019) Irvington Road and I-19 – Design and reconstruct new TI (SPUI)
19-6	57-64	7	High	81%	None	High	Programmed Ajo Way TI - Reconstruct TI and Mainline (2015, 2018) Reconstruct I-19 to four lanes in each direction between San Xavier Road and I-10 (I-19 DCR) Irvington Road and I-19 – Design and reconstruct new TI (SPUI) Planned Capacity expansion planned entire segment listed in various planning documents All interchanges planned for upgrade

The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial deficiencies from the Step 1 template to Column D of the Step 2 template.

Step 2.2

Column E represents the percentage of weekend traffic days (Fri-Sun) where, when the daily traffic volume for each weekend day is plugged into the Primary Mobility Index calculation for the existing volume, the resultant index score falls within the 'Poor' threshold.

Step 2.2.1 – Using the Task 2 Mobility Performance Index spreadsheet, determine the threshold for which the existing traffic volume input (Column 'I' of the Mobility Index) results in a 'Poor' score for the primary Mobility Index (Column 'N' of the Mobility Index) for each segment (Note – this will be a different number for each segment).

Step 2.2.2 – Using the 365 day permanent count station dataset for the corridor, select the most current year with a full 365 day set of data (or the most complete) for each permanent count station.

Step 2.2.3 – Count how many weekend days (Fri-Sun) eclipse the threshold determined in Step 2.2.1 above and divide by 365 to get the percentage of weekend days to input in Column D for each segment with a permanent count station.

Step 2.3

Identify recently completed or under construction projects (Column F&G) that would be considered relevant to mobility performance. Include only projects that were constructed after 2013 for which the 2013 HPMS data used for traffic volumes would not include. Any completed or under construction roadway project after 2013 that has the potential to mitigate a mobility issue on a corridor segment should be listed in the template. Such projects should include the construction of new travel lanes or speed limit changes on the main corridor only. Do not include projects involving frontage roads or crossings as they would not impact the corridor level performance. Sources of recent or current project activity include ADOT MPD staff, ADOT public notices, and ADOT District staff.

Step 2.4

Update the Refined Deficiency (Column G) using the following criteria:

- If the percentage of weekend days that have a traffic volume resulting in a 'Poor' Mobility Index score is over 17% why 17%?, increase the Refined Deficiency (Column H) one level.
- If the percentage of weekend days that have a traffic volume resulting in a 'Poor' Mobility Index score is over 33% why 33%?, increase the Refined Deficiency (Column H) two levels.
- If a recent project (Column F&G) has superseded the performance rating data and it is certain the project addressed the deficiency, change the deficiency rating to "None".
- If a recent project (Column F&G) has superseded the performance rating data but it is uncertain that a project addressed the deficiency, maintain the current deficiency rating and note the uncertainty as a comment in Column I.

Step 2.5

Note any programmed projects that have the potential to mitigate any mobility deficiency on the segment in Column I. Programmed projects are provided as information and do not impact the deficiency rating. Programmed projects will be reviewed in the development of solution sets for identified needs and deficiencies. The source of the programming information can be found in ADOT's 5-year construction program. Other comments relevant to the needs analysis can be entered in the right-most column (Column I).

Step 3: Contributing Factors

The Refined Deficiency ratings from Step 2 will populate into the Step 3 tab (Column D). The Step 3 sample template is illustrated in **Table 3** for the I-19 corridor.

Table 19 - Step 3 Example

The steps to compete Step 3 include:

Step 3.1

Input mobility-related data the will be carried forward from datasets used in Task 2, existing corridor performance (Column E through Column P).

Step 3.2

In columns Q and R, calculate the Buffer Index by subtracting the directional TTI value (from Task 2) from the direction PTI value (from Task 2) for each segment.

Step 3.3

In columns S and T input the percentages for weekday and weekend days that result in a 'Poor' Mobility Index score from Step 2.

Step 3.4

In the lower portion of Column E – Column I input the Closure Extents that have occurred along the study corridor. Road closure information can be detailed out by the reason for the closure as documented in Highway Condition Reporting System (HCRS) data analyzed as part of the baseline corridor performance. Closure reasons include incident/accidents, winter storms, obstruction hazards, and undefined closures. Statewide average percentages for the various closure reasons have been calculated for 2009-2013 on ADOT's nine designated strategic corridors. Compare these statewide average percentages to the corridor percentages for the various closure reasons to identify higher than average percentages of one or more closure reasons on any given segment. Summarize the closures as follows and use red text to indicate that the segment percentage exceeds statewide averages:

- Total Number of Closures (Column H)
- % Closures (No Reason) (Column I)
- % Incidents/Accidents (Column J)
- % Obstructions/Hazards (Column K)
- % Weather Related (Column L)

Step 3.5

In the lower portion of Column J, list the mobility-related infrastructure. (Relevant infrastructure may include DMS locations, travel lane configuration, or environment characteristics that impact mobility). Include the mileposts of the listed infrastructure if available.

Step 3.6

In the lower portion of Column K, list the non-actionable conditions that are present within each segment by milepost if possible. Non-Actionable conditions are conditions that exist within the environment of each segment that cannot be improved through an engineered solution. For example, the border patrol check point in Segment 3 of I-19 is a non-actionable condition. If the non-actionable condition is the main reason for the performance score on any given segment, adjust the Final Level of Deficiency accordingly (Column T).

Step 3.7

Considering all information in Steps 1-3, identify the contributing factors to the Refined Deficiency (Lower portion of Column L – Column S).

Step 3.7

After reviewing all of the information provided in Step 3, determine a Final Deficiency level for each segment. The Final Deficiency Level only deviates from the Refined Deficiency if the more detailed analysis of Step 3 identified a previously unknown mobility performance issue (which would increase the deficiency level), or identified no observable mobility performance issues (which would decrease the deficiency level).

Safety Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Safety Performance Area. The 5-step process is listed below. When Step 3 is completed for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to identify common or overlapping deficiencies for multiple performance areas. Corridor deficiencies are then translated to needs in Step 5 of the process.

- Step 1: Initial Deficiencies
- Step 2: Refined Deficiencies
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

The Task 4 - Safety Excel spreadsheet contains 3 tabs, one each for Steps 1 - 3.

Step 1: Initial Deficiencies

The Step 1 sample template is illustrated in **Table 1** for the I-19 corridor:

The input required to populate the Step 1 template includes transferring the existing performance score and color for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Freight. As each performance score is input into the template, the Initial Deficiency (Column S) will populate based on the weighted scoring system for each measure.

The Level of Deficiency for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" within the Step 1 template.

To develop an aggregated Initial Deficiency for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Deficiency for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5).

The steps include:

Step 1.1

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from Task 2. Copy the performance score and color for each segment to the appropriate "Performance Score" column.

Step 1.2

Confirm that the following criteria for "Insufficient Data" has been applied and that the resulting Level of Deficiency has been shown as "Unknown" where applicable.

- Crash frequency for a segment is less than 5 crashes over the 5-year crash analysis period.
- The change in +/- 1 crash results in the change of deficiency level of 2 levels (i.e., changes from Good to Poor or changes from Poor to Good).
- The average segment crash frequency for the overall corridor (total fatal plus incapacitating injury crash frequency divided by the number of corridor segments) is less than 2 per segment over the 5-year crash analysis period.

Step 1.3

Confirm that the Step 1 template is generating the appropriate "Level of Deficiency" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of deficiency.

Step 1 Template

Segment	Segment Mileposts	Segment Length (miles)	Safety Index			% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors			% of Fatal + Incapacitating Injury Crashes Involving Trucks			Initial Deficiency
			Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	Performance Score	Performance Objective	Level of Deficiency	
19-1	0-3	3	0.77	Fair or Better	Medium	Insufficient Data	Fair or Better	Unknown	Insufficient Data	Fair or Better	Unknown	Medium
19-2	3-18	15	1.13	Fair or Better	None	68%	Fair or Better	Low	16%	Fair or Better	None	Low
19-3	18-30	12	1.42	Fair or Better	None	50%	Fair or Better	None	10%	Fair or Better	None	None
19-4	30-40	9	1.12	Fair or Better	None	61%	Fair or Better	Medium	17%	Fair or Better	None	Low
19-5	40-57	18	0.95	Fair or Better	Medium	43%	Fair or Better	None	16%	Fair or Better	None	Medium
19-6	57-64	7	1.27	Fair or Better	None	61%	Fair or Better	None	22%	Fair or Better	None	None
Weighted Average			1.13	Good	Low							

Scale

Measure		None >=	Low >=	> Medium <	High <=	
Safety Index (Corridor)		1.29	1.07	1.07	0.84	0.84
Safety Index (Segment)		1.07	0.95	0.95	0.73	0.73
% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	Urban	63.33%	71.00%	71.00%	86.34%	86.34%
	Rural	55.67%	60.00%	60.00%	68.66%	68.66%
% of Fatal + Incapacitating Injury Crashes Involving Trucks	Urban	25.67%	27.00%	27.00%	29.66%	29.66%
	Rural	29.67%	31.00%	31.00%	33.66%	33.66%

THIS IS AN EMPHASIS AREA SO THE OBJECTIVE IS HIGHER PERFORMANCE

Step 2: Refined Deficiencies

The Initial Deficiency will be carried over to Step 2 (Column D). The Step 2 sample template is illustrated in **Table 2** for the I-40 corridor. The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial deficiencies from the Step 1 template to Column D of the Step 2 template.

Step 2.2

Using the crash concentration (hot-spot) map developed as part of the baseline corridor performance, determine the direction of travel and approximate milepost limits of each hot spot. Rate each hot spot as a "Localized", "Medium", or "Large" hot spot using the following criteria and list the hot spots in Column E.

- Large crash concentration is 6+ crashes within the vicinity of the defined hot spot.
- Medium crash concentration is 3-5 crashes within the vicinity of the defined hot spot.
- Localized crash concentration is < 3 crashes within the vicinity of the defined hot spot.

Step 2.3

Identify recently completed or under construction projects (Column F) that would be considered relevant to safety performance. Include only projects that were not taken into account during the crash data analysis period (2009 – 2013). Any completed or under construction roadway project after 2013 that has the potential to mitigate a safety issue on a corridor segment should be listed in the template. Sources of recent or current project activity can include ADOT MPD staff, ADOT public notices, and ADOT District staff.

Step 2.4

Update the Refined Deficiency (Column G) based on the following criteria:

- If a Large crash concentration exists on a segment, upgrade the Refined Deficiency rating by 2 deficiency levels. For example, for a segment with an initial deficiency rating of "Low" that also has a Large crash concentration, the Refined Deficiency would be "High".
- If a Medium crash concentration exists on a segment, upgrade the Refined Deficiency rating by 1 deficiency level. For example, for a segment with an initial deficiency rating of "Low" that also has a Medium crash concentration, the Refined Deficiency would be "Medium".
- If a Localized crash concentration exists on a segment, no upgrade to the Refined Deficiency rating is applied.
- After the Refined Deficiency has been updated based on the above criteria, the deficiency rating can be upgraded or downgraded using engineering judgement. For example, if a recently completed or ongoing project has a potential to resolve the identified deficiency, downgrade the deficiency rating by one level.

Step 2.5

Note any programmed projects that could have the potential to mitigate any safety deficiency on the segment in Column H. Programmed projects are provided as information and do not impact the deficiency rating. Programmed projects will be reviewed in the development of solution sets for identified needs and deficiencies. The source of the programming information can be found in ADOT's 5-year construction program.

Step 2 Template

Segment	Segment Mileposts (MP)	Segment Length (Miles)	Initial Deficiency	Deficiency Adjustments		Refined Deficiency	Programmed Projects
				Hot Spots Size (# Crashes) MP	Recently Completed or Under Construction Projects (which supersede performance data)		
19-1	0-3	3	Medium	Localized (0) NB 9.48-9.7	None	Medium	None
19-2	3-18	15	Low	None	None	Low	Planned (see WP #1) I-19/Grand Avenue Partial Interchange – Interchange Improvement I-19 "The Curve", Safety Corridor Improvements I-19, Exit 22 (Peck Canyon Rd) to Exit 48 (Arivaca Road) – Interchange Improvements I-19, Tumacacori to Tubac Wildlife Preservation Crossings
19-3	18-30	12	None	None	None	None	None
19-4	30-40	9	Low	Medium (3) NB 30.39-31.33 Medium (3) NB 33.05-34.08 Low (2) NB 38.88-39.79	Ongoing Pavement Preservation MP 31.8-42.5	Low	Programmed Project (FY 2015) Canoa Shoulders - Construct Shoulder Widening
19-5	40-57	18	Medium	Medium (3) NB 43.06-43.87 Medium (3) NB 44.77-45.57 Large (6) NB 53.40-54.46 Medium (3) NB 55.15-56.14 Medium (5) SB 47.64-48.69 Localized (1) SB 54.43-54.73	None	High	Planned (see WP #1) Esperanza, Duval Mine Rd, Helmet Peak, Pima Mine Rd, Papago TI reconstruction projects listed in various planning documents Capacity expansion planned entire segment listed in various planning documents
19-6	57-64	7	None	Medium (3) NB 58.05-58.81 Medium (4) NB 59.85-60.50 Large (7) NB 61.74-62.76 Medium (3) SB 61.59-62.10	None	Medium	Programmed Ajo Way TI - Reconstruct TI and Mainline (2015, 2018) Reconstruct I-19 to four lanes in each direction between San Xavier Road and I-10 (I-19 DCR) Irvington Road and I-19 – Design and reconstruct new TI (SPUI) Planned (see WP #1) Capacity expansion planned entire segment listed in various planning documents All interchanges planned for upgrade

Instructions
1. Input values for Deficiency Summary (Column C) from Step 1
2. Input Hot Spots (Column D) by segment identified during the Performance Assessment
3. Identify recently completed or under construction projects (where improvements are not accounted for in data collected) for each segment (Column E)
4. Update Resulting Deficiency (Column G) using the following criteria:
 - **If Large crash concentration (typically 6+ Crashes), upgrade deficiency rating by 2**
 - **If Medium crash concentration (typically 3 - 5 Crashes) , upgrade deficiency rating by 1**
 - **If Localized crash concentration (typically less than 3 Crashes) , no upgrade to deficiency rating**
 5. Ongoing pavement preservation or bridge improvement project downgrade deficiency rating by 1
6. Identify any programmed projects relevent to segment needs

Step 3: Contributing Factors

The Refined Deficiency ratings from Step 2 will populate into the Step 3 tab (Column D). The Step 3 sample template is illustrated in **Table 3** for the I-19 corridor.

A separate *Crash Summary* spreadsheet contains summaries for 6 crash types for the entire corridor, for each corridor segment, and for statewide roadways with similar operating environments (the database of crashes on roadways with similar operating environments was developed in Task 2 (the baseline corridor performance)). The crash type summaries are consistent with the annual ADOT Publication, *Crash Facts*. The 6 crash type summaries consist of the following:

- First Harmful Event (FHET)
- Crash Type (CT)
- Violation or Behavior (VB)
- Lighting Condition (LC)
- Roadway Surface Type (RST)
- First Unit Event (FUE)

Non-colored tabs in this spreadsheet auto-populate with filtered crash attributes. Each tab is described below:

- **Step 3 Summary** – This tab contains the filtered summary of crashes that exceed statewide thresholds for crashes on roadways with similar operating environments. Data in this tab are copied into the Step 3 template.
- **Statewide** – This tab contains a summary of statewide crashes from roadways with similar operating environments filtered by area type (Rural/Urban) and the 6 crash type summaries listed above. The crash type summaries calculate statewide crash thresholds (% total for fatal plus incapacitating crashes). The crash thresholds were developed to provide a statewide expected proportion of crash attributes against which the corridor and corridor segments crash attributes can be compared. The crash thresholds were developed using the *Probability of Specific Crash Types Exceeding a Threshold Proportion* as shown in the Highway Safety Manual, Volume 1 (2010). The thresholds are automatically calculated within the spreadsheet. The threshold proportion was calculated as follows:

$$p*_i = \frac{\sum N_{Observed,i}}{\sum N_{Observed,i(total)}}$$

Where:

$p*_i$ = Threshold proportion

$\sum N_{Observed,i}$ = Sum of observed target crash frequency within the population

$\sum N_{Observed,i(total)}$ = Sum of total observed crash frequency within the population

A minimum crash sample size of 5 crashes over the 5-year crash analysis period is required for a threshold exceedance to be displayed in the Step 3 template. The probability of exceeding the crash threshold was not calculated to simplify the process.

- **Corridor** – A summary of corridor-wide crashes filtered by the 6 crash type summaries listed above.
- **Segment FHET** – A segment-by-segment summary of crashes filtered by first harmful event attributes.
- **Segment CT** – A segment-by-segment summary of crashes filtered by crash type attributes.
- **Segment VB** - A segment-by-segment summary of crashes filtered by violation or behavior attributes.
- **Segment LC** – A segment-by-segment summary of crashes filtered by lighting condition attributes.
- **Segment RST** – A segment-by-segment summary of crashes filtered by roadway surface attributes.
- **Segment FUE** – A segment-by-segment summary of crashes filtered by first unit event attributes.

The tabs highlighted in yellow are programmed to automatically filter crash data from the ADOT crash database to create corridor ("CORRIDOR_DATA") and statewide ("STATE_DATA") filtered crash data. The 6 crash types must be inserted into the appropriate column in order for these tabs to be populated correctly. Note that statewide database was filtered for similar "operating environments" during Task 2 using traffic volumes, number of lanes, and rural vs. urban area as criteria.

The steps to compete Step 3 include:

Step 3.1

Filter data from the ADOT database for the "CORRIDOR_DATA" and "STATE_DATA" tabs by inserting the following data in the appropriate columns that are highlighted in red for both the Corridor and State tabs:

- Incident Crossing Feature (MP)
- Incident Injury Severity
- Incident First harmful Description
- Incident Collision Manner
- Incident Lighting Condition Description
- Surface Condition
- Unit Event Sequence 1
- Personal Violation

Step 3 Template

		19-1	19-2	19-3	19-4	19-5	19-6	Corridor-Wide Fatal & Serious Injury Crashes
Refined Deficiency		Medium	Low	None	Low	High	Medium	
Segment Crash Overview		2 Crashes were fatal 1 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	11 Crashes were fatal 11 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	3 Crashes were fatal 6 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	6 Crashes were fatal 9 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	19 Crashes were fatal 20 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	7 Crashes were fatal 10 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles	48 Crashes were fatal 57 Crashes had incapacitating injuries 0 Crashes involve trucks 0 Crashes involve Motorcycles
Segment Crash Summaries (Fatal and Serious Injury Crashes)	First Harmful Event Type	No crashes occur at a rate higher than the statewide average	23% Involve Collision with Fixed Object	No crashes occur at a rate higher than the statewide average	No crashes occur at a rate higher than the statewide average	36% Involve Collision with Motor Vehicle 15% Involve Collision with Fixed Object	47% Involve Collision with Motor Vehicle	8% Involve Collision with Pedestrian 30% Involve Collision with Motor Vehicle 20% Involve Collision with Fixed Object
	Collision Type	No crashes occur at a rate higher than the statewide average	73% Involve Single Vehicle	56% Involve Single Vehicle	No crashes occur at a rate higher than the statewide average	13% Involve Sideswipe (same) 13% Involve Rear End	35% Involve Rear End	10% Involve Sideswipe (same) 10% Involve Other 14% Involve Rear End
	Violation or Behavior	No crashes occur at a rate higher than the statewide average	23% Involve Other 36% Involve No Improper Action	No crashes occur at a rate higher than the statewide average	47% Involve No Improper Action	15% Involve Failure to Keep in Proper Lane 28% Involve No Improper Action	No crashes occur at a rate higher than the statewide average	15% Involve Other 30% Involve No Improper Action 11% Involve Unknown
	Lighting Conditions	No crashes occur at a rate higher than the statewide average	No crashes occur at a rate higher than the statewide average	56% Occur in Dark-Unlighted Conditions	33% Occur in Dark-Unlighted Conditions	77% Occur in Daylight Conditions	29% Occur in Dark-Lighted Conditions 35% Occur in Dark-Unlighted Conditions	6% Occur in Dark-Lighted Conditions 61% Occur in Daylight Conditions 0% Occur in Dark-Lighted Conditions
	Surface Conditions	No crashes occur at a rate higher than the statewide average	95% Involve Dry Conditions	89% Involve Dry Conditions	93% Involve Dry Conditions	95% Involve Dry Conditions	94% Involve Dry Conditions	6% Involve Wet Conditions 91% Involve Dry Conditions Involve Snow Conditions
	First Unit Event	No crashes occur at a rate higher than the statewide average	27% Involve a first unit event of Motor Vehicle in Transport	No crashes occur at a rate higher than the statewide average	33% Involve a first unit event of Motor Vehicle in Transport	38% Involve a first unit event of Motor Vehicle in Transport 15% Involve a first unit event of Equipment Failure	59% Involve a first unit event of Motor Vehicle in Transport	38% Involve a first unit event of Motor Vehicle in Transport 16% Involve a first unit event of Equipment Failure 6% Involve a first unit event of Overturn
Hot Spot Crash Summaries		No hot stop crash concentration located in this segment	Hot spot in NB direction from MP 9.48-9.7	No hot stop crash concentration located in this segment	Hot spot located in NB direction from MP 30.39-31.33, 33.05-34.08, and 38.88-39.79	Hot spots located in NB from MP 43.06-43.87; 44.77-45.57; 53.40-54.46; 55.15-56.14 and in SB direction from MP 47.64-48.69; 54.43-54.73	Hot spots lcoated in NB direction from MP 58.05-58.81; 59.85-60.50; 61.74-62.76 and in SB direction from MP 61.59-62.10	
Previously Completed Safety-Related Projects		None	None	None	Ongoing Pavement Preservation MP 31.8-42.5	None	None	
District Interviews/Discussions		pending	pending	pending	pending	High number of fatal crashes near Green Valley. Increased number of crashes due to alcohol from casino patrons	pending	
Contributing Factors		Insufficient Data, deficiency level lowered to NONE	● Single vehicle ● Vehicle in transport	● Single vehicle ● Traffic control device reflectivity	● Traffic control device reflectivity ● Vehicle in transport **Comment:** Canoa Shoulders Widening project may improve safety	● Vehicle in transport ● Improper lane changes ● Higher traffic volume operating conditions ● Urban operating conditions **Comment:** Five interchanges and identified in planning documents for reconstruction/improvements as well as planned added capacity may address safety issues in congested conditions	● Vehicle in transport ● Traffic control device reflectivity ● Improper lane changes ● Higher traffic volume operating conditions ● Urban operating conditions **Comment:** Planned and programmed added capacity and TI reconstruction throughout segment may address safety issues in congested conditions	
Final Deficiency		None	Low	None	Low	High	Medium	

Table generated using Crash_Summary Spreadsheet
1. Copy and paste (values only) table from the "Step_3_Summary" tab in the Crash_Summary Spreadsheet.
2. Only show the segments that have an identified deficiency (i.e., Low, Medium, or High).
3. Manually remove 0% values
4. Summarize crash Hot Spots. Small or localized hotspots will likely not have any observable patterns.
5. Summarize previously completed projects that include improvements known to influence safety performance.
6. Summarize contributing factors
7. Summarize input from district interviews/discussions only if it validates a contributing factor

In the CORRIDOR_DATA tab, populate the yellow MP INTEGER column (Column F) to display an integer of the Incident Crossing Feature or Mile Post. Construct an Excel formula to sort the mile post information by corridor segment (Column G). Note a common formula cannot be created since all corridors have different segment lengths and mile posts.

Step 3.3

In the STATE_DATA tab, fill in the column for the Similar Operating Environment (SOE) Type (Column F) with the corresponding designation for each crash. In the I-40 example, there are two SOEs: rural and urban.

Step 3.4

In the Statewide tab, a column of tables is needed for each SOE type. In the I-40 example, there are two columns of tables: one for the rural SOE and one for the urban SOE. Update the formulas in the Fatal and Injury columns of each table to match the corresponding SOE type.

Step 3.5

In the Calcs tab, a column is needed for each SOE type that references the total percentages of each crash type from the Statewide tab for each respective SOE type. In the I-40 example, there are two columns of tables: one for the rural SOE and one for the urban SOE. Update the formulas in the Comparison to SOE column for each segment to reference the corresponding SOE Type Total column. For the Corridor column, select the SOE Type Total column that is most representative of the corridor.

Step 3.6

Because some crash attributes are of finer detail than is required to summarize the crash data, a number of crash attributes can be combined into a single attribute. For example, crashes can contain various attributes for animal-involved crashes. The crash attributes that involve an animal were combined into a common attribute, such as "ANIMAL". This will allow the summaries to be consistent with the ADOT *Crash Facts*. The attributes that require manual adjustment include:

Combined Attribute	Database Crash Attributes
ANIMAL	ANIMAL_WILD_GAME, ANIMAL_LIVESTOCK, ANIMAL_PET, ANIMAL_WILD_NON_GAME
OTHER_FIXED_OBJECT	GUARDRAIL_FACE, GUARDRAIL_END, TREE_BUSH_STUMP_STANDING, CULVERT, TRAFFIC_SIGN_SUPPORT, FENCE, CONCRETE_TRAFFIC_BARRIER, OTHER_POST_POLE_OR_SUPPORT, BRIDGE_OVERHEAD_STRUCTURE, BRIDE_RAIL, MAILBOX
OTHER_NON_COLLISION	EMBANKMENT, DITCH, RAN_OFF_ROAD_LEFT, RAN_OFF_ROAD_RIGHT, FELL_JUMPED_FROM_VEHICLE, JACKKNIFE CARGO_LOSS_OR_SHIFT, VEHICLE_IMMERSION, SEPERATION_OF_UNITS
OTHER_NON_FIXED_OBJECT	OTHER_NON_FIXED_OBJECT, WORK_ZONE_MAINTENANCE_EQUIPMENT, PARKED_MOTOR_VEHICLE, TRAINS, RAILWAY VEHICLES

Step 3.7

Confirm that the crash database is being properly filtered by comparing crash frequencies from the summary tables with the frequencies developed in Task 2. For example, the lookup function will fail if the filter is for "NO IMPROPER ACTION" if the database has the attribute of "NO_IMPROPER_ACTION".

Step 3.8

Copy and paste the Step_3_Summary into the Task 4 – Safety spreadsheet in the Step 3 tab. Paste values only and remove the summaries with "0%s" for a clean display.

Step 3.9

The Step 3 table in the Task 4 – Safety spreadsheet should be similar to the Step 3 template. In the Segment Crash Summaries row, the crash attributes that exceed the statewide crash threshold are displayed at both the segment and corridor level.

Step 3.10

Provide a summary of any observable patterns found within the crash Hot Spots, if any exist in the segments.

Step 3.11

Input any historic projects (going no further back than 2000) that can be related to improving safety. Projects more than five years old may have exceeded their respective design life and could be contributing factors to safety performance deficiencies.

Step 3.12

Input key points from District interviews or any important information from past discussions with District staff that is consistent with deficiencies and crash patterns identified as part of the performance and needs assessment as this may be useful in identifying contributing causes. This information may be obtained from District Maintenance personnel by requesting the mile post locations that may be considered safety issues.

Step 3.13

Considering all information in Steps 1-3, list the contributing factors using engineering judgment and the information on contributing factors available in Section 6.2 of the 2010 Highway Safety Manual. Add comments as needed on additional information related to contributing factors that may have been provided by input from ADOT staff.

Step 3.14

After reviewing all of the information provided in Step 3, determine a Final Deficiency level for each segment. This deficiency level would only deviate from the Refined Deficiency if the more detailed analysis of Step 3 identified a previously unknown safety performance issue (which would increase the deficiency level), or identified that there are no observable crash patterns (which would decrease the deficiency level).

Freight Needs Assessment Methodology (Steps 1-3)

This section documents the approach for conducting the first three steps of a 5-step needs assessment process for the Freight Performance Area. The 5-step process is listed below. When Step 3 is completed for all performance areas (Pavement, Bridge, Mobility, Safety, and Freight), Step 4 will review each corridor segment to identify common or overlapping deficiencies for multiple performance areas. Corridor deficiencies are then translated to needs in Step 5 of the process.

- Step 1: Initial Deficiencies
- Step 2: Refined Deficiencies
- Step 3: Contributing Factors
- Step 4: Segment Review
- Step 5: Corridor Needs

The Task 4 - Freight Excel spreadsheet contains 3 tabs for Steps 1 - 3.

Step 1: Initial Deficiencies

The Step 1 sample template is illustrated in **Table 1** for the I-40 corridor.

The input required to populate the Step 1 template includes transferring the existing performance score and color for each segment to the appropriate "Performance Score" columns. This includes the primary and secondary measures for Freight. As each performance score is input into the template, the Initial Deficiency (Column S) will populate based on the weighted scoring system for each measure.

The Level of Deficiency for each performance measure has levels of "None" (score = 0), "Low" (score = 1), "Medium" (score = 2), and "High" (score = 3). The assignment of these levels to individual performance measures for segments is determined by the table entitled "Needs Assessment Scales" within the Step 1 template.

To develop an aggregated Initial Deficiency for each segment, the primary and secondary measures are combined by summing the weighted scored, with the primary measure having a weight of 1.0 while each secondary measure has a weight of 0.2 (0.1 each direction if directional). The Initial Deficiency for each segment (combining the primary and secondary measures) has levels of "None" (score < 0.01), "Low" (score $\geq$ 0.01 and < 1.5), "Medium" (score $\geq$ 1.5 and < 2.5), and "High" (score $\geq$ 2.5).

The steps include:

Step 1.1

Populate the Step 1 template with the existing (baseline) performance scores for all primary and secondary performance measures from task 2. Copy the performance score and color for each segment to the appropriate "Performance Score" column.

Step 1.2

Confirm that that the Step 1 template is generating the appropriate "Level of Deficiency" for each primary and secondary measure by reviewing the relationship of baseline performance score to level of deficiency.

Step 1 Template

Segment	Segment Mileposts	Segment Length (miles)	Freight Index			Directional TTI (trucks only)						Directional PTI (trucks only)						Closure Duration (hours/mile/year)			Initial Deficiency
			Performance Score	Performance Objective	Level of Deficiency	Performance Score		Performance Objective	Level of Deficiency		Performance Score		Performance Objective	Level of Deficiency		Performance Score	Performance Objective	Level of Deficiency	
						NB	SB		NB	SB	NB	SB		NB	SB				
19-1	0-3	3	0.46	Fair or Better	High	1.54	1.08	Fair or Better	High	None	2.37	1.96	Fair or Better	High	High	0.97	Fair or Better	None	High
19-2	3-18	15	0.92	Fair or Better	None	1.04	1.04	Fair or Better	None	None	1.09	1.08	Fair or Better	None	None	1.35	Fair or Better	None	None
19-3	18-30	12	0.34	Fair or Better	High	1.43	1.03	Fair or Better	High	None	4.91	1.06	Fair or Better	High	None	1.25	Fair or Better	None	High
19-4	30-40	9	0.95	Fair or Better	None	1.02	1.03	Fair or Better	None	None	1.05	1.06	Fair or Better	None	None	0.90	Fair or Better	None	None
19-5	40-57	18	0.95	Fair or Better	None	1.03	1.03	Fair or Better	None	None	1.05	1.06	Fair or Better	None	None	1.17	Fair or Better	None	None
19-6	57-64	7	0.89	Fair or Better	None	1.02	1.09	Fair or Better	None	None	1.06	1.20	Fair or Better	None	None	4.67	Fair or Better	None	None
Weighted Average			0.80	Good	Low															

Scale

Measure	None >=	Low >=	> Medium <		High <=
Freight Index (Corridor)	0.8	0.74	0.74	0.67	0.67
Freight Index (Segment)	0.74	0.7	0.7	0.64	0.64
Directional TTI	1.21	1.27	1.27	1.39	1.39
Directional PTI	1.37	1.43	1.43	1.57	1.57
Closure Duration	6.72	12.64	12.64	24.46	24.46

Step 2: Refined Deficiencies

The Initial Deficiency will be carried over to Step 2 (Column D). The Step 2 sample template is illustrated in **Table 2** for the I-19 corridor.

The steps required to complete Step 2 are as follows:

Step 2.1

Confirm that the template has properly populated the initial deficiencies from the Step 1 template to Column D of the Step 2 template.

Step 2.2

Note in Column E any truck height restriction hot spots (clearance < 16') identified as part of the baseline corridor performance using the data provided by the ADOT Intermodal Transportation Department Engineering Permits Section. For each entry, note the milepost of the height restriction and if the height restriction can be detoured by ramping around the obstruction. If it is not possible for a truck to ramp around the height restriction, note the existing height as well.

Step 2.3

Identify recently completed or under construction projects (Column F) that would be considered relevant to freight performance. Include only projects that were not taken into account during the freight data analysis period (2009-2013). Any completed or under construction roadway project after 2013 that has the potential to mitigate a freight issue on a corridor segment should be listed in the template. Such projects can include the construction of climbing lanes or Dynamic Message Signs (DMS) installation. Sources of recent or current project activity can be ADOT MPD staff, ADOT public notices, and ADOT District staff.

Step 2.4

Update the Refined Deficiency (Column G) using the following criteria:

- If there is one or more truck height restriction hot spots (Column E) where a truck cannot ramp around, increase (i.e., worsen) the initial deficiency rating by 1 category.
- If a recent project (Column F) has superseded the performance rating data and it is certain the project addressed the deficiency, change the deficiency rating to "None".
- If a recent project (Column F) has superseded the performance rating data but it is uncertain that a project addressed the deficiency, maintain the current deficiency rating and note the uncertainty as a comment in Column H.

Step 2.5

Note any programmed projects that could have the potential to mitigate any freight deficiency on the segment in Column H. Programmed projects are provided as information and do not impact the deficiency rating. Programmed projects will be reviewed in the development of solution sets for identified needs and deficiencies. The source of the programming information can be found in ADOT's 5-year construction program. If there are other comments relevant to the needs analysis, they can be entered in the right-most column (Column H).

Step 2 Template

Segment	Segment Mileposts (MP)	Segment Length (miles)	Initial Deficiency	Deficiency Adjustments		Refined Deficiency	Programmed Projects/Comments Relevant to Refined Deficiency
				Truck Height Restriction Hot Spots (Clearance < 16')	Relevant Recently Completed or Under Construction Projects (which supersede performance data)		
19-1	0-3	3	High	None	None	High	Planned (see WP #1) I-19, I-19B Terminus to West Street - Roadway Improvements for Future Capacity I-19 and Mariposa TI reconfiguration
19-2	3-18	15	None	MP 13.96 NB Peak Canyon TI UP- can ramp around	None	None	Planned (see WP #1) I-19, SR 189/Mariposa Road TI to Tumacocori TI – Roadway Improvements for Future Capacity I-19 and Mariposa TI reconfiguration
19-3	18-30	12	High	MP 26.94 NB Agua Linda TI UP can ramp around	None	High	Programmed Project (FY 2015) Canoa Shoulders - Construct Shoulder Widening

Step 3: Contributing Factors

The Refined Deficiency ratings from Step 2 will populate into the Step 3 tab (Column D). The Step 3 sample template is illustrated in **Table 3** for the I-19 corridor.

The steps to compete Step 3 include:

Step 3.1

Input any freight-related infrastructure (Column E) that currently exists on the corridor for each segment. The relevant infrastructure can include DMS locations, weigh stations, Ports of Entry (POE), rest areas, parking areas, and climbing lanes. Include the mileposts of the listed infrastructure. This data can be extracted from the 2012 Highway Log and the 2015 Climbing and Passing Lane Prioritization Study.

Step 3.2

For deficiencies in directional Truck Planning Time Index (TPTI), review the ADOT roadway inventory, ADOT HCRS data, ADOT highway logs, and ADOT Climbing Lane study recommendations and document the milepost limits and roadway features that may be contributing to the deficiency in Column F. Discussions with District staff may also help to determine contributing factors for travel time deficiencies.

Step 3.3

For deficiencies in directional Truck Travel Time Index (TTTI), review the ADOT roadway inventory, ADOT HCRS data, ADOT highway logs, and ADOT Climbing Lane study recommendations and document the milepost limits and roadway features that may be contributing to the deficiency in Column G. Discussions with District staff may also help to determine contributing factors for travel time deficiencies.

Step 3.4

For columns H - L, summarize the Closure Extents that have occurred along the study corridor. Road closure information can be detailed out by the reason for the closure as documented in Highway Condition Reporting System (HCRS) data analyzed as part of the baseline corridor performance. Closure reasons include incident/accidents, winter storms, obstruction hazards, and undefined closures. Statewide average percentages for the various closure reasons have been calculated for 2009-2013 on ADOT's nine designated strategic corridors. Compare these statewide average percentages to the corridor percentages for the various closure reasons to identify higher than average percentages of one or more closure reasons on any given segment. Summarize the closures as follows and use red text to indicate that the segment percentage exceeds statewide averages:

- Total Number of Closures (Column H)
- % Closures (No Reason) (Column I)
- % Incidents/Accidents (Column J)
- % Obstructions/Hazards (Column K)
- % Weather Related (Column L)

Step 3.5

Input any programmed and planned projects or issues that have been identified from previous documents or studies that are relevant to the Refined Deficiency (Column M). Sources for this data include the 2012 Highway Log, the 2015 Climbing and Passing Lane Prioritization Study, and ADOT's 5-year construction program.

Step 3.6

Considering all information in Steps 1-3, identify the contributing factors to the Refined Deficiency (Column N). Potential contributing factors to deficiencies in freight performance include roadway vertical grade, number of lanes, traffic volume-to-capacity ratios, presence/lack of a climbing lanes, and road closures. Also identify higher than average percentages of one or more closure reasons on any given segment.

Step 3.7

After reviewing all of the information provided in Step 3, determine a Final Deficiency level for each segment. This deficiency level would only deviate from the Refined Deficiency if the more detailed analysis of Step 3 identified a previously unknown freight performance issue (which would increase the deficiency level), or identified that there are no observable freight performance issues (which would decrease the deficiency level).

Step 3 Template

Segment	Segment Mileposts (MP)	Segment Length (miles)	Refined Deficiency	Relevant Freight-Related Existing Infrastructure	Directional Truck Planning Time Index (TPTI)	Directional Truck Travel Time Index (TTTI)	Total Number of Closures	% Closures (No Reason)	%Incidents/ Accidents	% Obstructions/ Hazards	%Weather Related	Programmed and Planned Projects or Issues from Previous Documents Relevant to Refined Deficiency	Contributing Factors to Refined Deficiency	Final Deficiency
							Closure Extent							
19-1	0-3	3	High	Mariposa Land Port of Entry in Nogales on SR 189 MP 0.12 Variable Message Sign	see Contributing Factors	see Contributing Factors	6	0%	83%	0%	17%	No passing lanes current or planned.	Transition from surface street to controlled access freeway; average segment speeds fall significantly below posted speeds. Heavy truck traffic origin/destination via Mariposa TI and SR 189 contributes to congestion/delay in immediate vicintiy of TI.	High
19-2	3-18	15	None	None	None	None	30	0%	97%	3%	0%	No passing lanes current or planned.	None	None
19-3	18-30	12	High	None	see Contributing Factors	see Contributing Factors	9	0%	78%	22%	0%	No passing lanes current or planned.	MP 25.00 NB Border Patrol Check Station at Tubac requires all traffic to stop for inspection, causing average speeds to fall significantly below posted speeds. This is considered a non-actionable item by ADOT	None
19-4	30-40	9	None	None	None	None	12	8%	83%	8%	0%	No passing lanes current or planned.	None	None
19-5	40-57	18	None	None	None	None	42	0%	100%	0%	0%	No passing lanes current or planned.	None	None
19-6	57-64	7	None	MP 58.10 Variable Message Sign	None	None	21	33%	67%	0%	0%	No passing lanes current or planned.	None	None
						Statewide HCRS Database Closure Type Average %	16%	76%	3%	5%				
				Note: For freight, relevant existing infrastructure includes DMS, Weigh Stations, POE, Rest Areas, Parking Areas, and Climbing Lanes								Note: Existing and Planned Infrastructure Source: 2012 Highway Log, Climbing and Passing Lane Prioritization Study, ADOT 5-year Construction Program	Note: Statewide averages determined from Highway Condition Reporting System (HCRS) data for 2009-2013 for ADOT's nine designated strategic corridors Note: Roadway vertical grade, number of lanes, and presence/lack of a climbing lane should be a consideration if deficiencies are due to PTI or TTI	

Appendix B:

Corridor Needs Assessment Review and Comments

SUBMITTAL:	Draft Working Paper 4, Corridor Needs Assessment	PROJECT NAME:	I-19 Corridor Profile Study
REPORT DATE:	December 2014	ADOT WORK TASK NO. :	MPD 072A-14
REVIEWED BY:		ADOT CONTRACT NO.:	ADOT11-013177
DISCIPLINE/ OFFICE:		CONSULTANT:	URS Corporation

ACTION CODES:

A= WILL COMPLY   *B= CONSULTANT/DESIGNER TO EVALUATE

*C= COT TEAM TO EVALUATE   *D= DESIGN TEAM RECOMMENDS NO FURTHER ACTION

* REQUIRES A <u>WRITTEN EXPLANATION</u> AND FINAL DISPOSITION BY CONSULTANT

ITEM #	PAGE #	COMMENT / RESPONSE	DISPOSITION	
			INIT.	FINAL
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				